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JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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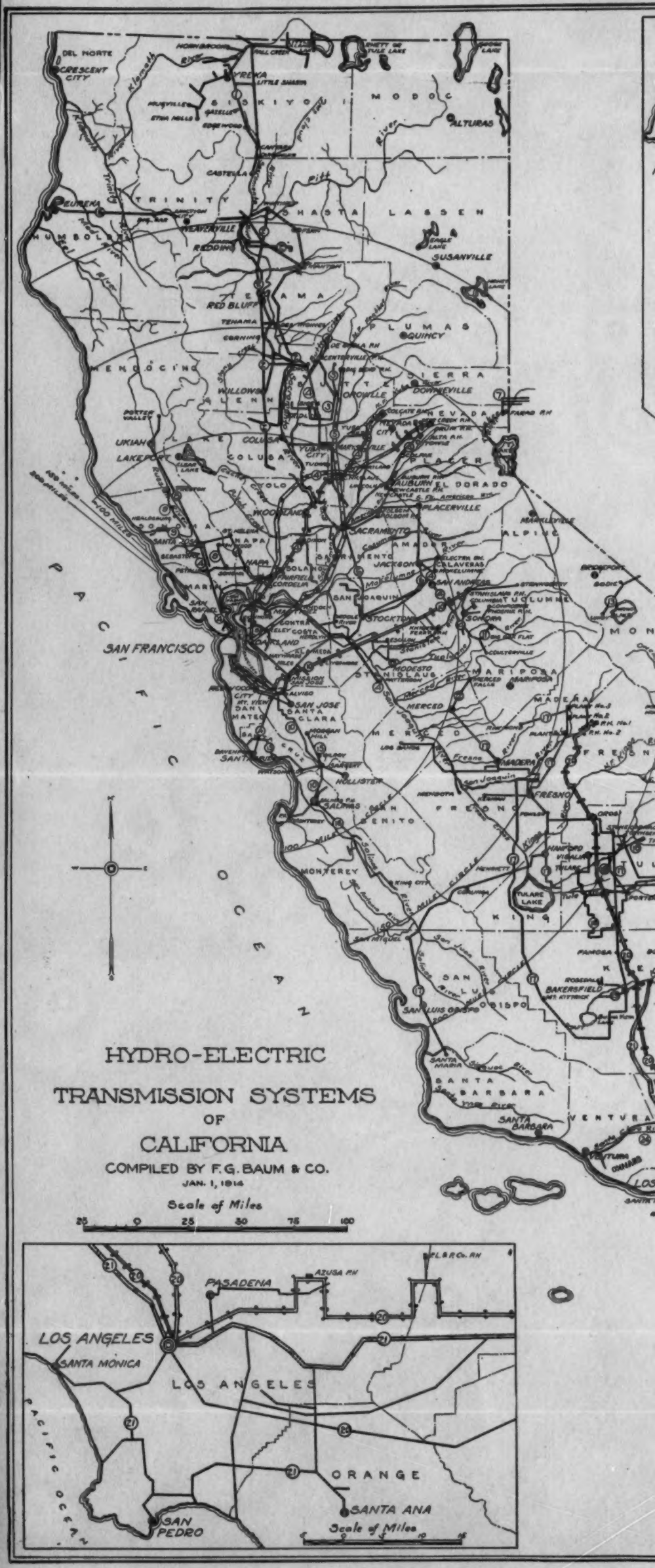
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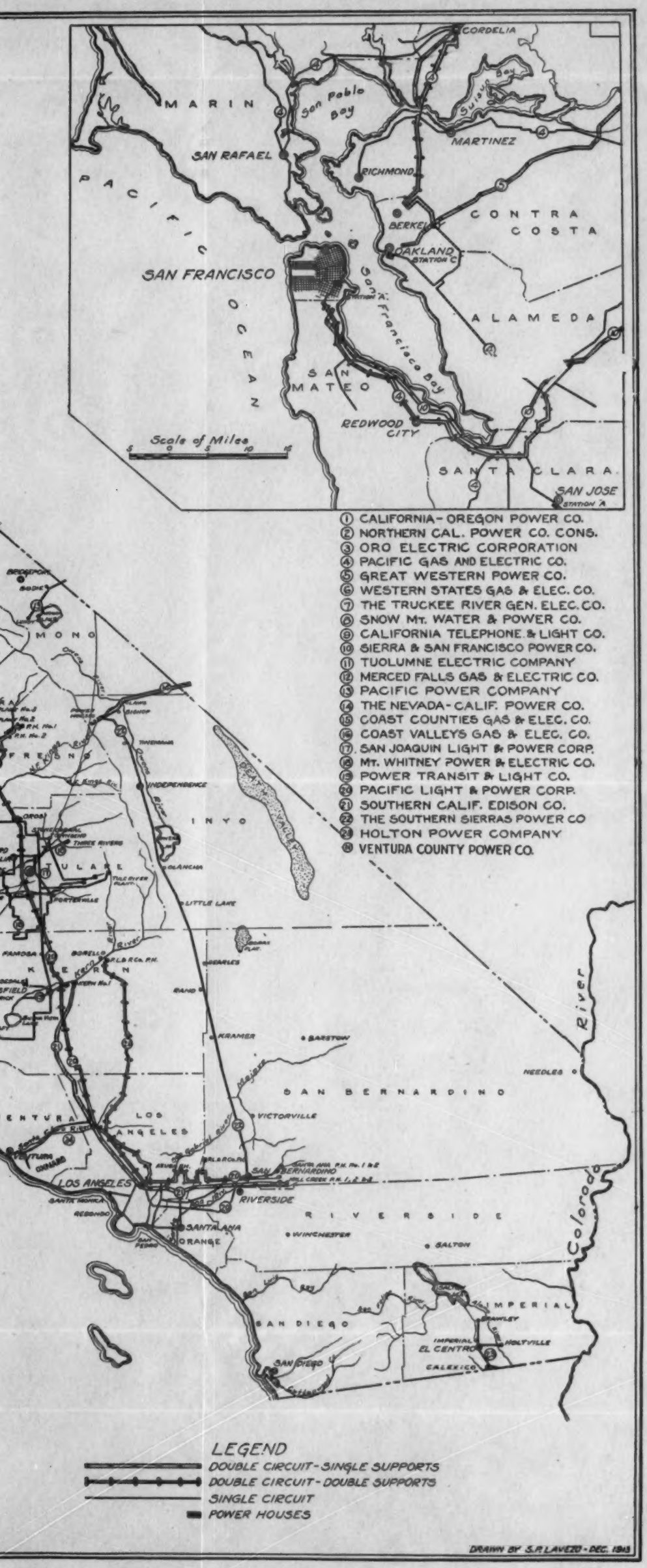

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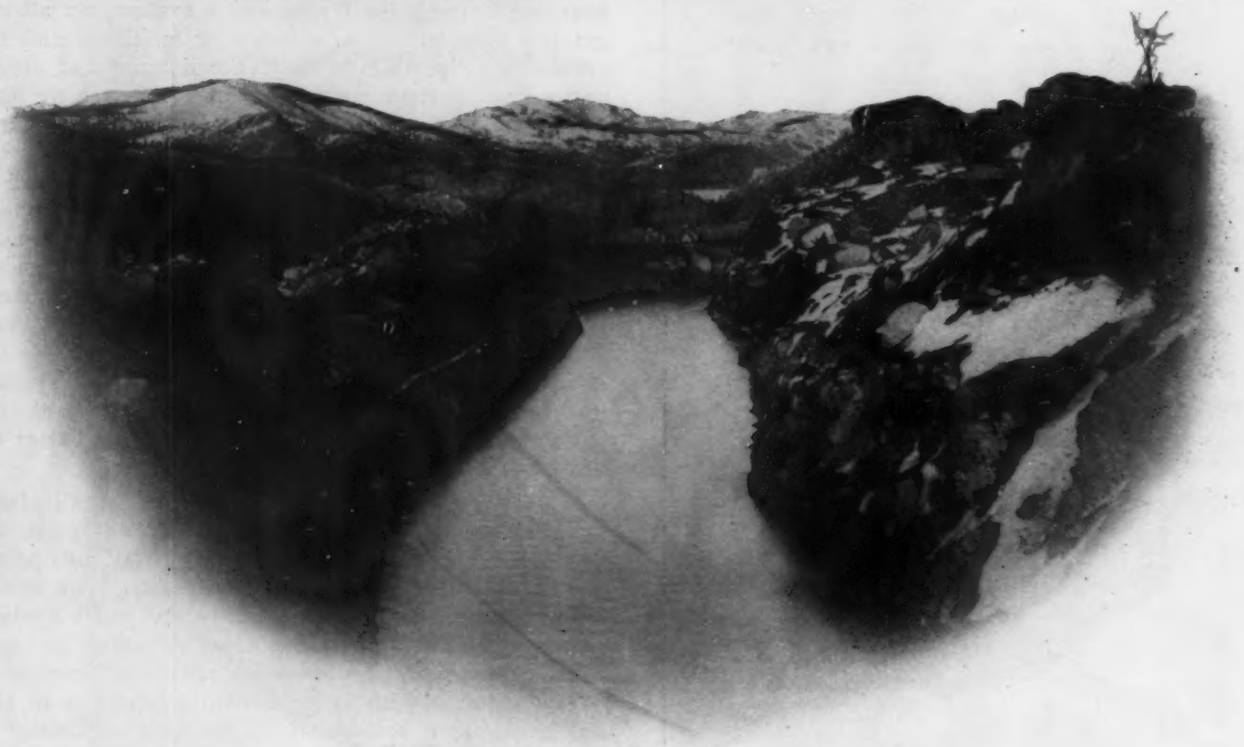


Drum Canal, Showing Spaulding Dam in Distance.

ECONOMIC VALUE OF ELECTRIC TRANSMISSION

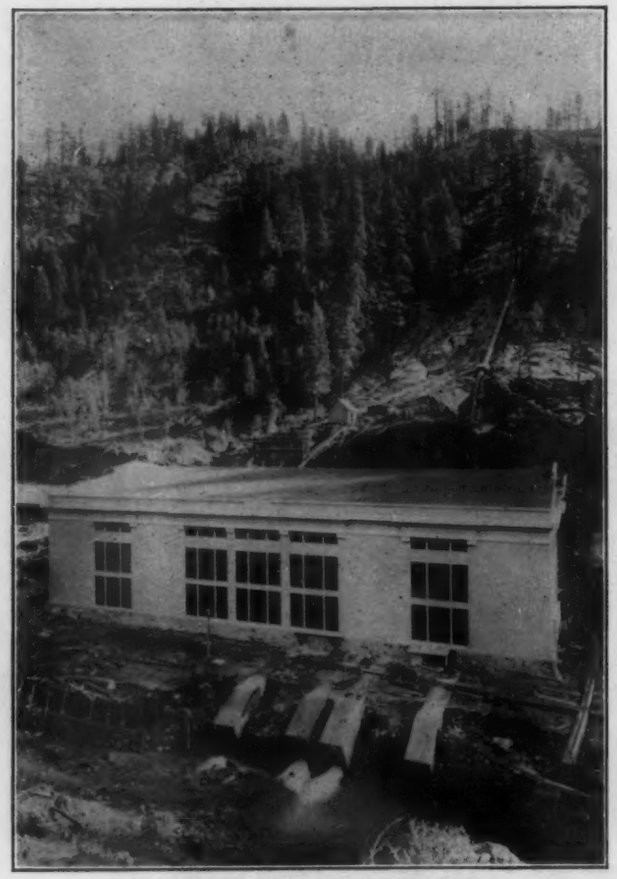
BY F. G. BAUM.

The men who built the first electric power transmission systems in California did not realize how rapidly and to what magnitude the business would grow. Yet in a general way they did appreciate the great advantages to be gained by a power transmission system furnishing power to operate various industries from large efficient power plants, instead of each industry supplying its own power from a small inefficient plant. The economy to the consumer in any particular case could of course be determined and the saving to the power user effectively shown. But as the power transmission lines operating as a unit have become larger and made to cover more and more territory, the additional advantages of having the large power system supported by a varied series of industries have added additional economy and stability to the large systems, and have also added general benefits to the industries and communities. The total result gives strong reasons for the increase of the electric transmission systems to cover generally a wider territory and more diversified industries.

To understand the reasons for this favorable condition resulting from the introduction of the electrical transmission systems is not difficult. We need only remember that any form of mechanical power can be efficiently converted into electric power and economically transmitted over long distances, subdivided into any number of parts, and instantly reconverted into some form of useful power at the place where wanted, in order to begin to appreciate that what is occurring is in response to fundamental economic laws. The high efficiency at which electric power may be generated, transmitted, subdivided and reconverted into mechanical or other useful power at any point along the transmission system is responsible for the use of electricity as the medium of mod-

ern power transmission and the continually increasing area covered by the electric transmission systems. This widening of the territory and the increased amount of power drawn from the transmission systems has been met by the installation of larger and larger generating units, until single units of 10,000 to 20,000 horsepower are now common, and operate continuously for days and weeks with less attention than is required by a 100 horsepower engine unit in a small factory.

In order to more thoroughly appreciate the advantages obtained by a large system, we must understand that no great amount of electricity can be



Drum Power House and Pipe Line.

stored. This means that the output of the power plants feeding into the transmission system must at each instant balance the power supply drawn from the lines, plus the transmission losses. Furthermore, the electric medium of power exchange between points of production and consumption operates instantly and efficiently.

To use an illustrative analogy, the large electric system may be compared to a bank in its economic function, and the electric medium of transmission may be compared to money, the medium of property exchange. If we had no money we would have to trade by direct exchange of property, and if we had money, but no banks in which to deposit our funds from which those of us who need it might draw, the difficulties of doing business may be imagined. Without a central power distributing system each consumer must develop his own power and have some surplus power. Hence there is no medium of exchange, no means of "banking" the total power of all on the transmission system, and no drawing at such points and in such amounts as may be needed from time to time. Electric transmission provides the elastic medium for exchanging any kind of mechanical power to any other form of mechanical power at some point on the system.

If one hundred isolated power plants are connected together by a transmission system and their power producing possibilities concentrated we will then be able to supply the demands of the one hundred original consumers and have a fair sized surplus always on hand. That is, by "banking" the individual energies through the transmission system, we all can get the convenience of the power facilities, and the system will be able to meet the demands of all its patrons and carry a surplus. This is because we have concentrated the surplus of the several plants and because our individual needs do not come at the same time. This surplus power is principally due to the fact that the diversity of interests now supplied from the one system is such that the system as a whole has a more uniform load, a better "load factor," than the separate plants when operating separately. In general, the more varied the interests which draw power from the lines, the more uniform will be the demand, and the better for the transmission system, just as the more varied the business of the bank, the more even the demands for money and the better for the bank and its patrons.

Having now connected the hundred small plants by an electric transmission system with a large power demand, we find we can no longer afford to operate the one hundred small plants, but instead we install a few large power units to supply the entire system, and by this means produce a large saving in operating expense. The economies resulting from large power systems with large central stations is in this way working a revolution in America, especially in California, and also in other countries. That this revolution is progressing from economic reasons which are fundamentally sound is certain, and therefore larger and larger electric power systems may be expected.

We may well inquire if these large power systems are to the advantage of the community as a whole, as one can see that in this revolution, as in other stages of progress, individual industries may be temporarily injured. A few simple considerations will show that electricity is one of the greatest influences for the stability of a country, for, as well known, to be stable, a country must be efficient, and it is now being more and more recognized that to be efficient it must use electric power. It is, of course, now becoming recognized that the most stable country is one in which the industries are diversified and also widely distributed.

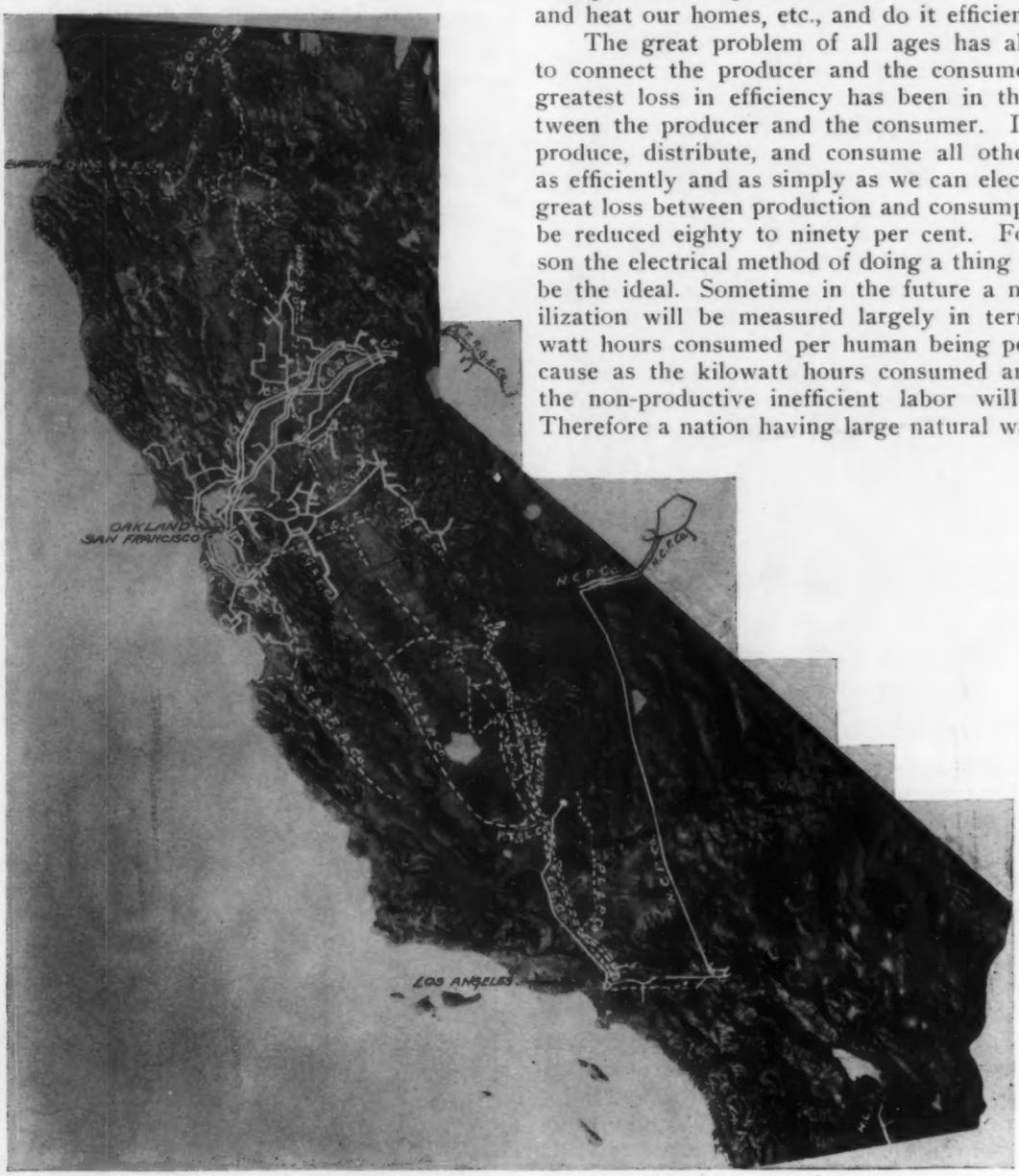
To bring about this diversion and distribution of interests and population the influence of the electric power systems (and especially the water power systems) is probably as great as that of the railroads. Some day nearly all railroads will be simply electrically-operated mechanical devices for the transpor-

tation of such things as must be moved in bulk, that is, practically all railroads will in time be electrically operated.

The stability of any civilization depends also on the fact that it consumes less than it produces. As it is necessary with an increasing population (the natural resources of a country being fixed and limited and the population increasing) to operate more and more efficiently in order to produce more than is consumed, the most efficient methods must be employed for all operations. Nature's naturally replenished sources of power must be used instead of consuming wood, coal, oil, etc., and the most natural source of power is falling water, which nature is always reproducing.

This water power, converted into the electric form for distribution and supplied to electric appliances for conversion into the form desired at the place desired, is the most efficient and convenient system imaginable. The electric method of doing a thing tends inherently to remain efficient, for inefficiency makes its appearance as heat, and heat means trouble, and as the human being wants to avoid trouble, there is inherent reason for efficiency. Starting with water power converted to electric power we can go on producing forever any mechanical operation; we can refertilize our lands, cultivate them, harvest and transport the crops to market, cook our meals, light and heat our homes, etc., and do it efficiently.

The great problem of all ages has always been to connect the producer and the consumer, and the greatest loss in efficiency has been in this step between the producer and the consumer. If we could produce, distribute, and consume all other products as efficiently and as simply as we can electricity, this great loss between production and consumption would be reduced eighty to ninety per cent. For this reason the electrical method of doing a thing will always be the ideal. Sometime in the future a nation's civilization will be measured largely in terms of kilowatt hours consumed per human being per year, because as the kilowatt hours consumed are large, so the non-productive inefficient labor will be small. Therefore a nation having large natural water powers need never fear decay. Hence we see the general benefits accruing to all the people, an unearned increment so to speak, as a result of the electric transmission systems. The electrical transmission systems will ultimately form a network all over the country just as the railroads have gridironed the states in the past.

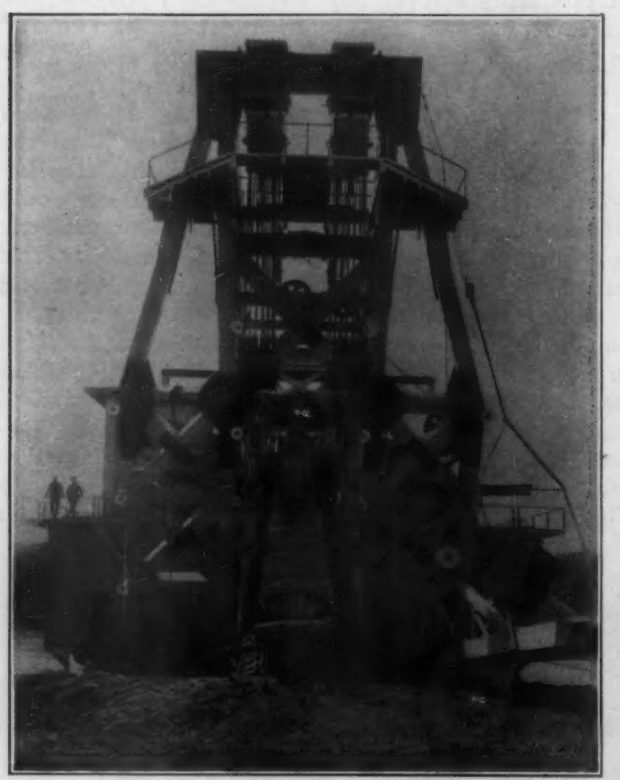


Electric Power Transmission Lines of California.

To illustrate the saving of capital and operating expenses, and the distribution of industries throughout an area, let us consider the conditions in California, especially the central part of the state, where one

of the largest systems in the world has been built up in the last fifteen years.

To more thoroughly appreciate the changes wrought in California by the hydroelectric power transmission systems, we must go back to 1897 and 1898. At that time there were independent and local



Electric Driven Gold Dredge.

steam plants in all the cities and towns of California. These plants supplied current for lighting only, and manufacturing concerns provided themselves with power from small plants which rapidly depreciated. The cost of lighting was 15c per kilowatt hour in the small towns, and power costs to manufacturing companies in most cases about two hundred dollars per horsepower year.

The mines on the Mother Lode had largely been abandoned, gold dredging had not yet proved feasible, no cement plants had yet been established, and wheat farming was rapidly declining. In a few isolated cases the farmers had begun to pump water for irrigation by means of gas engines, and lands were held at ridiculously low prices, but could not be sold, and Southern Pacific common stock, which is an index of California prosperity, was held at $30 per share because it could not be sold. It will be recalled that 1897 and 1898 were dry years, so that the farmers were praying for rain, the merchant for business, and on the whole conditions were as discouraging as seemed possible.

The only signs of hope were the several electrical plants that were starting about that time in the Sierras —"brain storms of de Sabla and Martin," they were called. Small hydroelectric plants were installed to supply power to the Grass Valley mines, and to the Mother Lode at Sutter Creek, Jackson, etc. The success of these plants caused the installation of a plant to supply power to Marysville, and caused the extension of a line from the Mokelumne River to Stockton, and the building of the first part of Colgate and a transmission to Sacramento.

As each plant was installed and the lines extended, careful measurements and tests were made to try to answer the question, "Is it feasible to transmit power commercially successful from the Sierras to the Bay of San Francisco?" The answer being in the affirmative, these bold pioneers proceeded to raise money to build the plants and lines to Oakland and San Francisco.

Most of the power is produced on various mountain streams from water power, the sources of power being about 150 miles from San Francisco. From each of these plants lines are built in the general direction leading to Oakland and San Francisco. Considering Oakland or San Francisco as the hub of a wheel, the power lines would appear as the spokes, the plants being located at the ends of the spokes. In some cases lines connect also from one plant to the other, or several plants are connected together on the rim of the wheel, bearing out the further resemblance to a wheel, the connecting lines between the plants being the felloes, or the tire connecting the spokes. On the rim of this wheel are also large power consumers made up of some large mining communities, etc., and on the spokes of the wheels are a number of cities, towns, factories, etc.; for example, Sacramento, Stockton, Oroville, Marysville, San Jose, Woodland, and many others, also several large cement plants, numerous gold dredgers, large street car systems, innumerable small factories, many small pumping plants both for irrigation and drainage, and the numerous consumers requiring light for stores, homes, and almost every conceivable use.

Reclamation and Irrigation by Electricity.

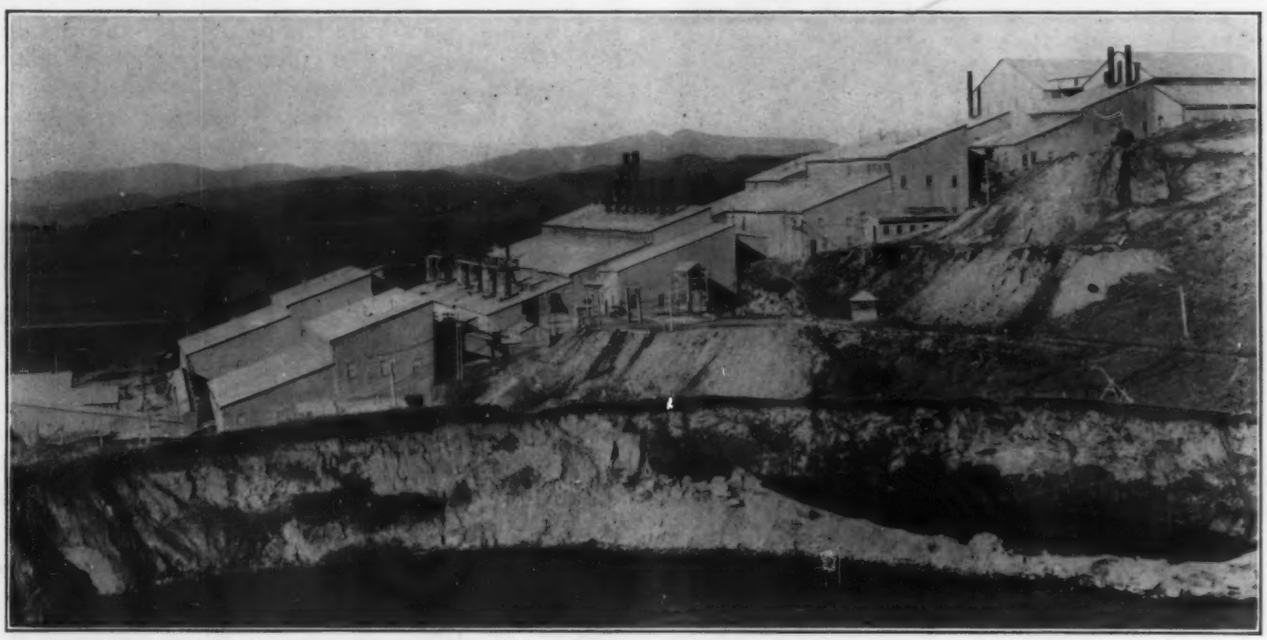
The result is, then, that power is transmitted over the transmission lines to the various points of use, the last of the water power being carried to the hub of the electric wheel, to Oakland and San Francisco. At these points large steam plants are provided for power service insurance, and to balance up the power supply and demand so that the water power plants may

as nearly as possible deliver their maximum output at all times. The arc of a circle covered by this large electric system is about 350 miles long, and the area covered is nearly 40,000 square miles, or an area sixty per cent as large as the state of New York. The average load on this system has grown to over 10,000 horsepower.

The result of such a system (and shown on the accompanying map of California) is that the same service in electric power is available at the mining camps in the mountains and to the small towns and industries in the central part of California as is supplied to the larger cities. Aside from the economies mentioned of such a system, resulting from the "banking" of the facilities, the power conditions throughout this area tend to become equalized, resulting in a distribution of population and industries not otherwise possible; and resulting in adding to the general stability of the country, and in great savings in capital and operating expenditures for the industries and cities served. Very often it enables the establishment of an industry, for example: a small factory, a rock quarry, a cement plant, a farm, etc., at a point otherwise prohibited, adding to the economic value of the district. The tendency is also to equalize rates for light and power, and to reduce rates to the lowest level. In small California cities the consumer of electric light or power gets much lower rates than ordinarily obtained in Eastern cities having local power stations.

In consequence of this electrical development industries are being established in many of the smaller towns and outlying districts where the employes can live more advantageously, and the natural effective result is a healthy growth of all parts of the state, a large saving in operating expenses, capital and resources, a general equalizing of opportunities, and on the whole a tremendous economic gain for the communities, increasing in geometric ratio. It is naturally to the interests of the people that the power systems be extended as rapidly as conditions warrant, as the resulting economies which will come from the extension of the business, will of necessity result in their benefit. For this reason, as I said before, California or any state or nation having available cheap power need never fear decay.

In California several practical illustrations may be seen in the conservation of water resources and the extension of the power systems. In one of these, flood waters are to be stored in a huge dam 300 ft. high, at an elevation of 5050 ft. above sea level, the dam alone costing over $2,000,000. After being released from the dam the water is successively passed through a series of six power houses, utilizing a total drop of 4140 ft. for power purposes, generating more than one hundred thousand constant horsepower, the water being discharged from the last power house at an elevation of 400 ft., and at this point the stored water is diverted into irrigation canals and more than 60,000 acres will be irrigated. This is practical conservation.



Electric Driven Cement Plant.

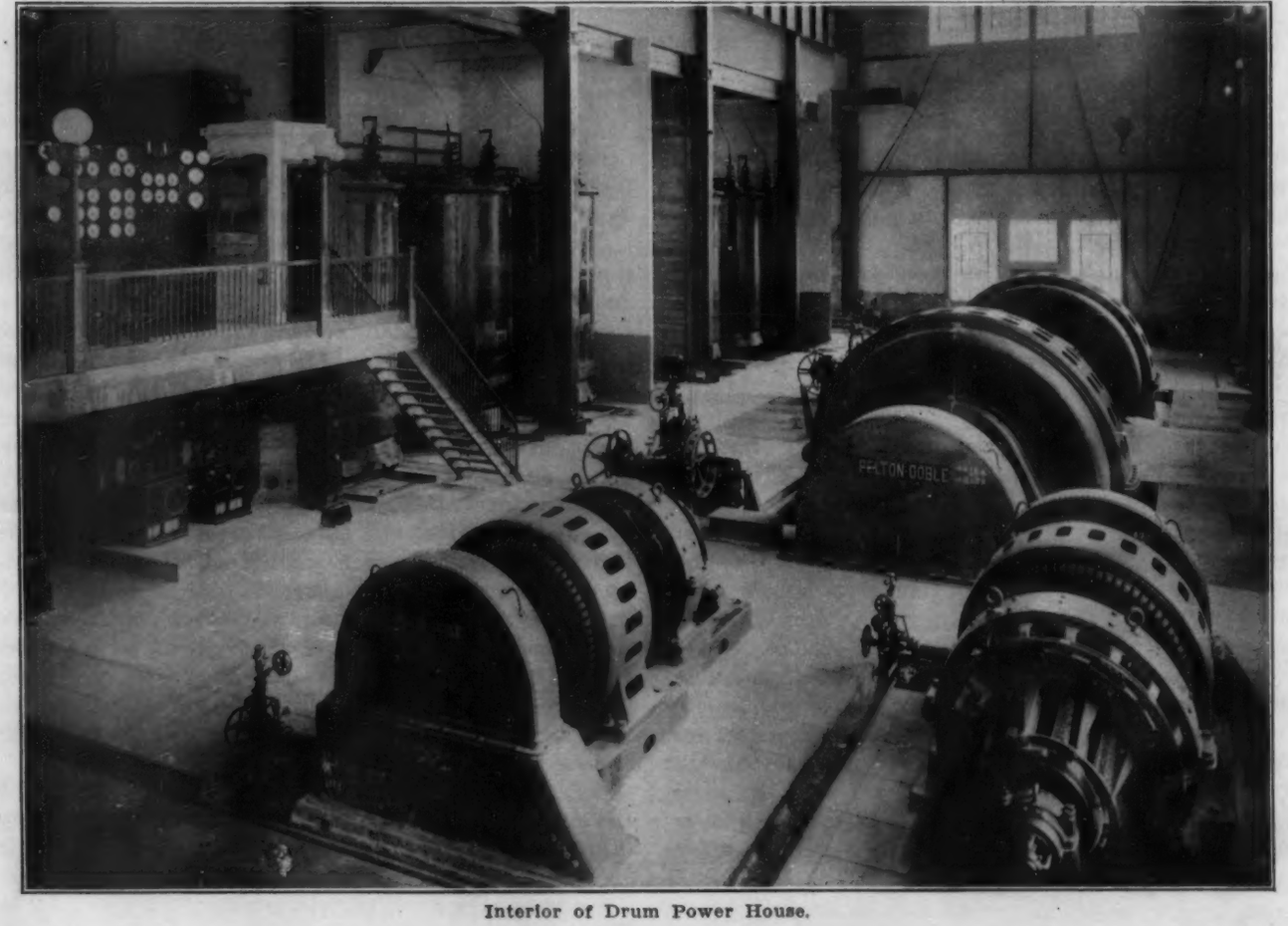
A glance at the map of California showing the development of electric transmission systems in the last fifteen years, and a knowledge of the undeveloped resources will give an idea of what has been accomplished and what may be the result twenty-five years hence. It follows that every encouragement should be given to develop water power as against steam power, in order to gain the advantages for California of the highest type of civilization, one that will endure to the end of time.

It requires no prophet to predict that within the life of most of us the steam locomotive will largely disappear, and that in its place will be the electric

Lake Spaulding Dam and Construction Plant, Present Height, 242 ft.; Ultimate, 322 ft.

motor, quietly, rapidly and effectively doing the future work of transportation, and it requires no prediction that the electric motor and other electrical devices will be largely responsible for future progress and advancement of civilization generally. In fact civilization and philosophy will be very much influenced and directed by electricity and its accomplishments. The philosophy of Marcus Aurelius and Confucius, who lived two thousand years ago is as sound as that of our modern philosophy, yet Rome decayed and China now sleeps. The electric transmission of intelligence and power would have prevented the decay of the former and would arrest the sleep of the latter. It is impossible to judge the future by the past without making full allowance for the changed conditions resulting from the modern transmission of information, power and products.

The transmission and distributing systems are gradually covering the entire state, forming an electrical metallic screen over the country. This is a screen of equal and constant potential under which service, opportunities, and rates tend to become equal. By building the transmission systems across and through the valleys of California, there is formed a system which makes for the uniform and stable development of the state as a whole. Not only this, but the hydroelectric companies use a waste to reduce a want. This gives us assurance for the future, for an increasing population requires progress, progress requires profits, profits requires efficiency, and we may claim in all modesty that modern business could not be carried on efficiently without electric power.



Interior of Drum Power House.

LIGHTING METHODS

LIGHTING METHODS INTRODUCED.

Knowledge is gained by observation and study, and through experience.

The object of this new department—Lighting Methods—is to diffuse information in such manner that by observation and study it may be converted into a valuable working knowledge for all those interested in the effective and efficient use of modern illuminants.

It is the dissemination of such practical information which makes for increased business, and results also in improved conditions.

But progress in the science of illuminating engineering, which presents the final word in methods pertaining to lighting, is so rapid that men and youths knowing but very little as a basis for their new work, have continually to be recruited. Then there is the busy man, architect, or whoever he may be who must gain knowledge of this kind in gulps. That he who runs may read, illustrated articles of installations typifying the latest developments will be published, and for the engineer, articles describing new methods and original research will from time to time also be included.

The new recruit, for the proper accomplishment of his purpose, whether he be an appliance salesman or salesmen of central station service, must begin at the beginning. The student also must commence here. The tyro, who would avoid trouble, both now and in the future, should realize the necessity for being well grounded in fundamentals, and the importance of securing accurate knowledge that the problems of those he would serve be properly solved.

While it is necessary to commence at the beginning, short cuts are possible, if not essential, and wherever feasible these will be presented.

Before words can collectively convey connected thought, their meaning has to be known. It is therefore important, more especially for the student or beginner, that the words in which Lighting Methods will be expressed, be properly defined, that the articles be fully understood. These will be published as rapidly as space will permit.

Correspondence is solicited from the readers of this department on any matters upon which they wish to elaborate or about those which may not be fully understood.

Our first article, "Decorative Periods Applied to Lighting Fixture Design" will indicate to the reader that it is our purpose to discuss Lighting Methods as completely as possible.

The artistic should not be subordinated to efficiency, but effectiveness—the proper adjustment of means to the end sought—should be the first consideration.

NOTEWORTHY LIGHTING EXHIBIT.

A miniature exhibit of lighting methods was shown by the Illuminating Engineering Society, at the International Exposition of Safety and Sanitation, held in the Grand Central Palace, New York, December 11 to 20, 1913, which was considered of such merit that it was awarded a grand prize.

The exhibit was remarkable and unique, and attracted the attention of mill owners and employees, school authorities and students, as well as architects, engineers, decorators and others interested in lighting methods.

Briefly, the exhibit presented striking examples of both good and bad lighting in the home, the school, store, mill, public conveyance, etc., and, in fact, covered almost every class of installation.

It was an excellent example of how some of the ordinarily dry-as dust facts of science may be made both interesting and instructive to non-technical people. Many thousands of those who were fortunate enough to see the exhibit were manifestly filled with wonder and surprise. They had known, of course, that light, particularly artificial light, is one of their immediate necessities; but just how much a common every-day thing may in numerous ways affect their health and happiness, few had better than a vague idea. That it may be employed to prevent a large number of industrial accidents, and to promote industrial efficiency, that it may effect strange and sometimes comic distortions of statuary and other objects of interiors—these, not to mention a host of other possibilities, were probably known to fewer still. Side by side in booths were models and pictures of good and bad lighting. Comparative conditions were clearly exposed. Uses and misuses of light, with their attending good or bad results, were indicated in ways which were at once striking and impressive. So apparent were the advantages and superiority of good lighting that one might have wondered why so many examples of bad illumination could be found. The latter fact is all the more curious when it is learned that good lighting may be had in many cases at a cost not much, if any greater than that paid for the poor illumination—in not a few instances it could be obtained for even less. It seemed evident that lighting may be good, bad, or otherwise, depending largely upon the care and skill with which it is planned.

The entire exhibit was installed under the direction of a special committee of the Illuminating Engineering Society, which gave considerable study and undertook quite a lot of experimentation that the exhibit planned would be most complete and successful. It was considered of such merit that it is to be placed in the American Museum of Safety, 29 West Thirty-ninth street, New York, where it may be seen free by the public.

DECORATIVE PERIODS APPLIED TO LIGHTING FIXTURE DESIGN.

BY F. N. COOLEY.

(In ths article, which is also an appeal for correctness in fixture design, the author describes the various periods thus far utilized and the historical associations of each. Mr. Cooley is fixture specialist with the Western Electric Company, San Francisco. —The Editors.)

To the casual observer, the detail, which is sometimes very carefully worked out in the design of lighting fixtures, is not always understood or appreciated. The fixture itself may be composed of very fancy curved arms, ornate but meaningless cast scrolls and ornamentation and still attract the average person's eye. But to the keen eye of the designer or architect, or a person who has made a study of decorative periods, each leafed ornament, cast canopy, extension or scroll, should bring out some distinct meaning.

Space will not permit of a thorough review of all the various periods of decoration which are recognized by the architects and decorators and such a review, while interesting from the artists' or historians' view point, would be superfluous in this article as but a small percentage of the many interesting periods are represented in the design of lighting fixtures.

We cannot go too far back however, by commencing with the Grecian ornaments. Evidence of this style is commonly used in the cast mouldings on body bands, break ornaments and canopy extensions. Our fixture industry would be in a sad plight if we could not bring into frequent use the egg and dart moulding effect. This ornament was originated in the fifth century, B. C., and used with most success in the Erechtheion, which is considered the most beautiful monument of Grecian art.

It was during this period that the Doric, Ionic and Corinthian designs originated, so much in use now by our architects. The Grecian period was divided into four epochs. First, the mythical period, sometimes termed the Heroic Epoch, which terminated about 1104 B. C.; second, the Doric or Archean period, from 1104 to 470 B. C.; third, the Ionic period from 470 to 338 B. C., and, fourth, the Hellenic period, from 338 to 146 B. C.

In Italy the Romans were dissatisfied with the simplicity of the Grecian designs and new designs sprung into existence there, called the Roman ornaments. These designs however, embodied, for the most part, Grecian ornaments but were greatly elaborated. Roman and Grecian designs became the standard of art and continued in prominence for many centuries.

In the 14th century the religious mysticism then prevailing found expression in a new design called the Gothic ornament. These ornaments were always expressions of harmony and are used for the greater part in the designing of our churches. The most significant emblem of the Gothic designs is the Gothic Arch.

During the 15th century, about 1420 A. D., a great change in the social conditions occurred in Italy which consequently effected religion, science and art. This universal re-birth was called in Italy the Rinascimento and by the French Renaissance.

Designs of this period at first greatly resembled the Gothic ornament which had had such full sway, but as the years passed these designs grew more and more individual and gradually spread all over Europe. France was the first to adopt these new ornaments and while the Gothic was slowly displaced by the new art, it took many years before it actually held full sway. This period is generally spoken of as the Renaissance period and is generally connected with the particular country affected, such as Italian Renaissance and French Renaissance and is divided generally into two epochs—early Renaissance 1500 to 1550 and high Renaissance 1550 to 1643.

The Renaissance period in Germany dates from about 1525 to 1620, as this country was very slow to adopt the radical changes from Gothic to the Renaissance designs prevailing in Italy and France. The oldest example of German Renaissance however, dates back to 1492, when the portal of the Castle of Mahrisch-Trubau was erected.

The Renaissance period prevailed in the Netherlands between the years of 1520 and 1621, but this class of art never reached the same height in perfection as did the Gothic designs.

Renaissance ornamentation gradually succumbed to a new and more elaboarte decoration called Barocco ornament and during the later Renaissance or Barocco periods the craze for more elaboration finally produced what is known as the Rococo design.

The Barocco period prevailed in most of the European countries during the 17th century and was known in France as Louis XIV style.

Barocco and Rococo design are in great evidence in the design of our modern lighting fixtures. Considerable criticism is due however, to uninformed designers who make use of various casting patterns and pressed leaf stampings without due regard of their relations to each other or to the general period they are trying to emphasize. An instance of this promiscuous use of ornamentation reminds the writer of a prominently placed chandelier on which were counted six representations of distinct influences. There is an old saying that "what the people don't know won't hurt them," but to the architect or interior decorator, these makeshifts of art are irritating and it is the architects and decorators who pass on the fixture design, especially if some particular period is to be represented. On the other hand there are manufacturers of lighting fixtures who appreciate the importance of correct design and employ designers who are well informed on decorative periods. The designing of a fixture is the first step in its creation and should receive the consideration it merits. The balance of its creation, while of importance, is purely mechanical.

During the years of 1720 and 1755 the Rococco decoration, as it was called in Germany and Louis XV style in France, was under full sway, and it is safe to say that few other decorative ornaments have been so widely used in fixture designing. In France the Louis XV ornament lost all semblance to symmetry, so strong was the demand for elaboration of leaved effect.

The Rococo or Louis XV designs dissolve the lines in free curves not bound with each other, under strict avoidance of symmetry.

This style was rarely used in Italy or the Netherlands but a style in England which was very popular at this time closely resembles it called Chippendale style named after Thomas Chippendale.

During the middle of the 18th century interest began to lapse in the flourishes and unsymmetry of the Rococo design and the work of substituting classic quiet and simplicity began. As the second Renaissance took place during the reign of Louis XVI this style was called, in France Louis XVI style, but was destroyed later, during the French revolution as was everything else that reminded the people of monarchy. Louis XVI designs were replaced by the Empire designs which are used extensively at the present time in the designing of our lighting fixtures. These designs embody mostly festoons of leaves and flowers and the wreath tied at the bottom or top with a bow of ribbon. This last ornament has been used unceasingly in the design of gas keys and finial ornaments.

The Empire ornaments were used in most of the European countries during the end of the 18th century and were admired in art circles mostly for their elegant and purely classic architectural form.

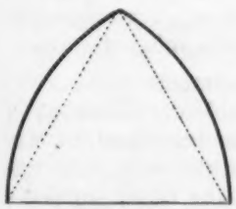
While all these famous decorative styles were being created and subsequently discarded in the European countries, a new country was being borne on the American continent. Naturally the United States at this time contained a representative class of artists and it will be easily understood that art styles were intimate with the designs predominating in the original country of the artist, but after a time all these different styles became united with one another forming themselves into the so-called Colonial style.

The old colonial buildings erected in New England states in 1725 to 1775, correspond somewhat to the Queen Anne and King George styles in England, and notwithstanding the European characteristics which they contain, the artistic creations of the 18th century in America possess certain national traits of their own.

We find among the Colonial designs, ornaments in hexagon and octagon patterns and as candles were extensively used in these pioneer days, the modern colonial lighting fixtures are equipped with imitation porcelain or enameled metal candles with frosted candelabra lamps to imitate the flame.

The relationship of Colonial designs can of course be traced directly to England and other countries and in fact there apparently is nothing strictly original in decoration, as the ornaments of each successive period obtain their origin from the period directly previous. However, additions and elaborations being added from time to time gradually change the lines until the resemblance of a few centuries before is lost.

We find in the Colonial design, a beading, commonly known as Colonial bead, which was used in Grecian architecture several centuries B. C., and the crystal pendant, the use of which is traced back as far as the 17th century.



Plain Ogive Arch (Gothic)

Bracket Candle Stick Town Hall of Augsburg

Acanthus Leaf in Barocco Style

Louis XV or Rococo Ornament

A Colonial Design

Colonial styles embody in the most part long sweeping but symmetrical curves. These lines are emphasized in the designing of spun or turned spindles for use on arms or pendants in shower fixtures while a lack of elaborate castings or scrolls is also noticeable in Colonial effects.

When Florida and the western country became settled and larger buildings erected, the inclination was naturally to resort to the Spanish Renaissance, and we still see plenty of evidence of this class of architecture in our California Missions and even in the newer buildings on the old Spanish Mission type. These styles, however, are strongly of the Gothic influences.

Since the lighting fixture industry is practically new and owing to the many methods of support of the lamp itself, no set of rules could be laid down which would guide the designer to correct period lines. The fixture designer must therefore be a good copyist, and an originator only in his methods of applying his copied patterns into his creation of the lighting fixture.

The importance of lighting glassware, properly designed to harmonize with the fixture both as regards period and correct usage, is now more than ever engaging the attention of architects and decorators, and new designs of lighting glassware adaptable to all purposes are daily appearing on the market to meet their requirements. This is but one more indication of the appreciation of architects and interior decorators of the value of correct lighting methods.

WASTE DUE TO NON-USE OF WATER POWER

BY W. V. N. POWELSON.

(This article, which is an analysis of the question of conservation of our natural resources, presents a convincing statement of the necessity for immediate development of water power now under Federal control. It is abstracted from United States Senate Document No. 243, which was presented by Mr. Shafroth.—The Editors.)

The time has come when, to preserve our character as friends of conservation, we must bring about the prompt development of those water power sites for which a market exists or can now be created.

Heretofore, because of our lack of knowledge of the subject, it did not seem good strategy in the fight for control of the water power sites in the public interest to move quickly toward their development. We needed time for study, reflection and counsel. It seemed imperative and sufficient that we employ all our resources to prevent private parties from acquiring the sites belonging to the public until a wise and constructive legislative plan for development could be devised.

While true conservation of our natural resources requires that our water power sites be promptly developed, true statesmanship requires that the development shall be made in harmony with the public interest.

A little reflection will show that it is possible that the evil of non-development, if continued long enough, may exceed the evil of unwise development.

The true interest of the public lies now between these two extremes. We can not remain in our present situation with a practical embargo on the development of sites now controlled by the government without important losses; nor can we without danger permit the development of these sites unless we retain an efficient governmental control over them after development.

As illustrating the extent of the Federal control of water power sites, I may say that it extends to every stream declared navigable, and to all sites on lands yet owned in fee by the government. That the amount of such land, particularly in mountainous sections, where the best sites are as a rule found, is enormous is shown by the data of the following table, which indicates certain states in which the area of Federal land exceeds 50 per cent of the total area of the states, and it is in these states and on these lands that the principal undeveloped water powers of the country are to be found.

Table Showing Approximately the Percentage of the Area of the Arid States Owned by the Federal Government.

State.	Total acreage owned by United States.	Percentage of total.
Arizona	67,097,293	92.00
California	53,276,547	52.58
Colorado	37,702,033	56.67
Idaho	45,218,919	83.80
Montana	61,049,263	65.80
Nevada	62,219,423	87.82
New Mexico	49,315,409	62.83
Oregon	32,229,745	51.90
Utah	43,564,645	80.18
Washington	17,684,198	40.00
Wyoming	42,613,499	68.00

Up to this time it has seemed the part of wisdom to counsel delay in dealing with a matter so important and so intricate. So far it has seemed the part of good strategy to throw away one thing of value to gain another which promised to be of greater value. But the process of throwing away the thing of value is still going on, and every day adds to its sum total.

We must not continue to throw away until we exceed the value of the thing we are striving for.

We have had ample opportunity during the past three years for reflection, study, and the preparation of our plans, and the people are now looking to the leaders of the conservation movement to come forward with a practical scheme of legislation that will bring about the speedy development of needed powers under an efficient public control and thus definitely put a stop to the enormous waste involved in the non-development of these powers.

Through the efforts mainly of Mr. Gifford Pinchot sensible men have come to recognize that there must be an efficient governmental control over these sites after development. There still exist differences of opinion as to details of this control, but the public interest requires that these differences be composed without further delay. What these differences seem to me to be I will describe later, after having first pointed out the tremendous waste of our natural resources involved in the continuance of economical available water power sites in an undeveloped state.

Waste by Non-Development.

The same amount of work is being done at a water power site whether it is undeveloped or developed. In the one case the work is mainly expended in agitating the water; in the other, in serving useful purposes. All over the country, wherever water runs, work is being performed, but at only comparatively few such places is this work being turned to useful purposes. While we are arguing about the details of a conceded public control, vast quantities of work are being thrown away which we might have in useful form for the harnessing. Once properly harnessed the work will have been permanently changed into a useful form and it then becomes a national asset of great value, which will forever provide useful employment for men.

Every undeveloped water power site for which a market exists, or could now be created, is a willful waste of a natural resource. If we do not make present use of the falling water of a stream, the useful work it is capable of doing is lost forever, and there is a waste of a natural resource. If, however, we do not make present use of coal in the ground, it will remain there in undiminished quantity and quality; we can at any future time convert it into useful work, and there is no waste of a natural resource.

It is just as wasteful of our natural resources to burn coal to do work that could as well be done by an undeveloped water power as it would be to permit an equal amount of coal to burn up underground. We see, therefore, that upon the sum total of our power resources the effect of an undeveloped water power in a locality where it could do work now being performed by coal is precisely as destructive in character as a coal deposit burning underground.

By a strange fatality many people have jumped to the conclusion that it is a conservation of our natural resources to keep our water power sites in their natural condition.

Because such a policy if applied to a coal field would be a policy of conservation, it does not follow that it retains this character when applied to water power sites. In fact, quite the contrary is true. A policy which in its practical effect results in non-development of our water power sites is not a policy of conservation at all, and its continuance can only be justified by a clear demonstration that the evil of this policy is less than the evil of any other policy that could be substituted for it.

For each (hydraulic) horsepower economically available for development there is now being substituted and burned 5½ tons of coal per year. This is based on a 12 hour day. At $2 per ton this is equivalent to a waste at the rate of $11 per year for each undeveloped horsepower now economically available for development.

Assuming that five million horsepower is undeveloped that can now be profitably developed, the non-development of this power represents an absolute waste today at the rate of 27,500,000 tons of coal per annum.

If the entire 32,000,000 minimum potential horsepower, as conservatively estimated, were developed, the total saving of coal would be about 175,000,000 tons per annum. It may be of interest to know that our present consumption of coal for all purposes is about 500,000,000 tons per annum, of which about 90 per cent is for industrial purposes. The average price of coal is probably in excess of $2 a ton, so that a measure of the present value of this waste would probably exceed $55,000,000 per annum.

Does not the possibility here presented of increasing the saving from 27,500,000 tons per annum to as near 175,000,000 tons as practicable present a field for fruitful endeavor on the part of the government? Does not the possibility of so tremendous a saving of our natural resources suggest that the attitude of the government should be at least sympathetic and not repressive? Does it not even suggest that the public welfare may soon require the principle of a bounty to encourage the development of its powers?

As against these tremendous losses to the nation, due solely to delay, what have we gained by the delay? What did we hope to gain by delay?

We have caused to be universally accepted the principle of an efficient government control, and we have preserved to the Federal Government the potential opportunity to collect a rental for the use of its water power sites.

I use the word "potential" because if the rental fixed is more than the traffic will bear at a particular site the development will not be made and no rental will be collected from it.

The most important and the important thing we have gained is universal recognition of the principle of an efficient governmental control.

It is probably not of vital consequence to the public welfare whether this control be exercised by representatives of the Federal or the state government. The important thing is that the control should be efficient and fair and in harmony with the public welfare.

Of far less consequence, to my mind, is the preservation to the Federal government of the "potential" opportunity to collect a rental from a site for the benefit of the public treasury, because I doubt the expediency of an attempt in this form to distribute to the people their fair share of the values flowing from the development of their sites.

Water powers, like city real estate, exhibit enormous differences in earning capacity. Many water powers have little or no commercial earning capacity in competition with coal. It would require in many cases a bounty to bring about their development. If we charge a rental on all water power sites at a uniform rate per horsepower of available capacity, only those sites will be developed that can stand the rental. Other sites that might have been developed under a smaller rental or under no rental at all will lie idle and valuable supplies of coal will be consumed to do their work. Is it not true that what we might collect for the people as a rental from a dozen developed water powers could easily be lost to the nation from the waste involved in a single undeveloped power whose development was prevented by the rental policy?

Fundamentally the question of a rental collected for the benefit of the public treasury is not a question of conservation at all. It is a social question contemplating an equitable division of potential profits, essentially the same as other social questions that have been correctly solved by governmental supervision and control of the service contracts and profits of public service corporations. No new form of wealth is created by the imposition and collection of such a rental or tax, and therefore each year we permit coal to be used to do work that can as economically be performed by water power we, as a nation, are being impoverished by the value of the coal so used, now estimated at about $55,000,000 per annum.

While I am in entire sympathy with the purpose of the rental charge, I must confess that, in my opinion, unless it be based in each particular case either on actual profits earned or on an agreed estimate of prospective profits prepared in each particular case as the result of a most skillful and exhaustive investigation, the rental policy, if applied generally, may do much more harm to the public welfare than good. But in suggesting that the rental policy may be impracticable, I am not suggesting any abandonment of the purposes for which that policy was suggested. Excessive profits, if earned, must be returned to the people, but it appears to me fundamental that an excessive profit must have been actually earned before a division is due, and the extent of the division must be controlled by the amount of the profit.

I admire the courage of the men who have prevented the development of our water power sites, their patriotism, their high purpose. I am not one of those who would impugn the motives of these men if they should now insist that these sites be continued a while longer in their natural condition. I would understand that they believed this policy necessary to the public welfare, but I would question their judgment.

I do not remember having heard it suggested in any quarter that the proposed rental should exceed around $1 per year per horsepower of site capacity,

and the fear has been expressed in some quarters that a charge exceeding 50 cents per horsepower might retard, if not prevent, the development of many otherwise economically available powers.

It may not be out of place to say here while considering the amount of the rental that water powers may be divided into three general classes. First, those capable of producing power considerably cheaper than by coal. The number of powers in this class is not very great. In the second class the saving over coal is small, and the margin of saving may be so small that mistakes in the estimate of cost or unusually adverse conditions during construction might easily make the difference between a success and a failure of the enterprise. In this class there are a very large number of powers. But the largest class of all consists of those powers that are not now economically available as competitors of coal.

Assuming that the traffic would bear an annual rental of $1 per horsepower of site capacity for the several million horsepower now, in the judgment of Mr. Herbert Knox Smith, economically available, then the largest sum which it has been suggested we gather into the public treasury from every undeveloped water power in the country, now economically available, is but $5,000,000 per annum, if by several million horsepower Mr. Smith means 5,000,000 horsepower. Let us assume for the purposes of discussion that the imposition of this rental or tax does create new wealth for the nation to the extent collected. How does this potential gain compensate for our losses, actual in the past and present, prospective in the future?

The losses which we are now suffering through waste of our natural resources—estimated at $55,000,000 per annum, or $11 per horsepower per annum—is the equivalent at 5 per cent of an annual sum in perpetuity equal to 55 cents per horsepower per annum on the whole 5,000,000 of economically available horsepower.

A delay of two years, therefore, represents a loss equivalent to an annual sum in perpetuity of more than $1 per horsepower on the whole 5,000,000 horsepower. A delay of three years, which I think it may be conceded we have experienced, has probably cost us the equivalent of a sum in perpetuity at the rate of $1.50 per year per horsepower on the whole 5,000,000 undeveloped horsepower.

A superficial view of the question might suggest that the country could recoup these past losses by charging a rental of $1.50 per horsepower per year and make a profit by charging a higher rental, but no country can enrich itself or recoup past losses by a tax, because a tax merely changes the ownership of a part of the wealth of the nation. We can never recoup for the nation the losses that have already been incurred, and it is our imperative duty to bend all our efforts to stop further waste.

I think it should be conceded that there would be considerable competition between the different groups skilled in water power development in this country and abroad if the opportunity were offered to develop those sites now controlled by the Federal government and that are economically available, and therefore it seems to me the part of wisdom for those having the public welfare at heart to ascertain at the earliest practicable moment the terms, the best under which responsible capital will come forward in competition to develop our powers, and, unless the acceptance of these terms will be more harmful to the public welfare than the continuance of our water powers in an undeveloped state, these terms should be accepted, and all parties should join in securing the legislation necessary to bring about the developments forthwith.

So far as I know, investors are not dissatisfied with the attitude toward capital as far as it pertains to the rate of return. No one is opposed to investors receiving a fair, even a liberal, return on their money devoted to water power development. While there are decided differences of opinion as to whether the governmental control should be Federal or state, the water power investor as a rule does not care which it is, provided it is not both at the same time. He insists that he serve but one master.

It is feared that if the control is dual a conflict might arise between the state and Federal authorities which would result in injury to the investor. There is a feeling, however, that because the state has an inalienable right to regulate public utility corporations doing business within its boundaries the Federal government should relinquish to the state its right to exercise a control, provided that the developing agent takes the form of a duly incorporated public service corporation, subject to and recognizing the state's right to supervise and control its acts. Since its revenue would be derived almost wholly from the sale of its power for public uses, it would not be a difficult matter to determine what its actual profits are, and the state, through its power to regulate, would always be in a position to place a reasonable limit upon those profits by reduction of prices, by taxation, or by both.

While there does not seem to be, other than the desire to eliminate a dual control, any marked preference on the part of the water power investors for Federal or state control, there does seem to exist a very marked preference for a Federal control on the part of those who have been heretofore most active in the conservation movement.

As I understand the matter, their preference for Federal control springs from a distrust of the state's machinery for control. They understand the advantage to any community accruing from the expenditure in it of very large sums of money on construction work, with the prospect of added population and employment after the power development has been made. They fear that if two states containing water power sites become active competitors for the expenditure of money in hydroelectric development capital might obtain concessions which would limit the opportunities of the people to participate to the extent they ought in the values created by the development. In other words, if I correctly understand their position, they regard the people of the general section in which the development is to be made as incapacitated through self-interest to look after the welfare of those to come after, and they desire that the Federal government shall exercise a guardianship over the future of the state, because they believe the Federal government to be free from the evil influences of self-interest.

A strong preference in favor of control by the

state is held by those who are citizens of the state and who believe that in the long run control by the state will be more truly responsive to the legitimate needs of both the people and the power companies. They point out that the uses to which these water powers will be put in the different parts of the country and the conditions surrounding these uses will be so different that it is doubtful whether a controlling body at long distance from the place of use can be made to understand and properly administer to the needs of the particular locality.

[To be continued.]

WHAT CONSTITUTES BENEFICIAL USE OF WATER IN IRRIGATION.

Under the laws of water rights as established by legislation and court decrees in the arid states of the West, the final test of a right to water for irrigation is that the water claimed shall be put to a beneficial use. As expressed by the laws of several states, "beneficial use is the basis, the measure, and the limit" of rights to water. These laws, however, do not attempt to define "beneficial use."

At a conference of the project managers of the U. S. Reclamation Service and representatives of the Department of Agriculture, held at Salt Lake, November 12-15, a resolution attempting such a definition was adopted. This definition is somewhat long and detailed, but in substance is as follows:

A water user is entitled to that "amount of water that will render him a reasonable maximum amount of good with a reasonable economic handling of the water." He is entitled to the protection of the state in this right, but, in return the state has a right to demand that he use reasonable care and judgment in conveying and using water and cultivating his crops.

The conference adopted also a definition of "economical use," which was in substance as follows:

Since the water supply available for irrigation in the Western states is adequate for only a relatively small percentage of the entire irrigable acreage, the fundamental standard of economical use must be the financial results accomplished per acre-foot of water applied, rather than the yield per acre irrigated. In future development the doctrine of beneficial use must in many cases merge into or be supplanted by that of economic use. The doctrine of beneficial use looks to individual interest: that of economic use to the general welfare of society as a whole. So far as possible, water charges, systems of distribution, and regulations should be so adjusted as to make the interest of the individual water user coincide with this public interest.

Customers Department is the satisfactory solution found by the Toledo Railways and Light Company to the problem of determining what name is best for that department which comes into direct contact with the consumer. Light and Power Department is popular usage in the West together with Contract Department which is also extensively used in the east. The name, Customers Department, is perhaps the most satisfactory yet used. It is easily understandable and is suggestive of a considerateness which inspires confidence.

WATTMETER READINGS AND POWER FACTOR OF BALANCED THREE-PHASE CIRCUITS.

BY A. R. HAYNES.

(The author appreciating fully the article on this subject which appeared in the November 29, 1913, issue of this journal, and realizing the practical value of this information, contributes from his notebook a viewpoint of this same subject from a different angle. The curve, Fig. 4, is in use at the General Electric Company's Testing Department and Laboratories. Mr. Haynes is chief operator, White River Station, Puget Sound Traction, Light & Power Company.—The Editors.)

The method of measuring power in three phase circuits by means of two single phase wattmeters or watthour meters is in general use and well understood, but the fact that the power factor may also be easily and accurately determined from these same readings or in the case of the watthour meters from the number of revolutions in a given time, when the circuit is balanced, is little known outside of testing laboratories. The peculiar behavior of one of the meters—reading sometimes positive, negative or zero; or in the case of watthour meters the disk running forwards, backwards or stopped—depends entirely upon the power factor of the circuit. The proofs and curves for obtaining the power factor of any balanced three phase circuit follow:

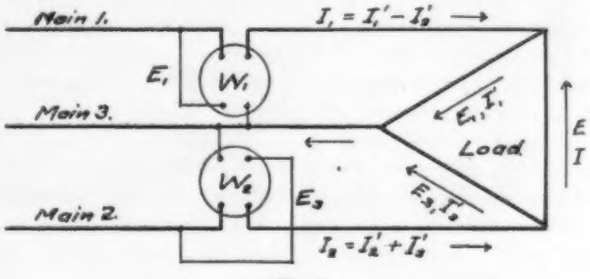


Fig. 1

Fig. 1 shows the ordinary connections of two single phase wattmeters for measuring the power of a three phase circuit. The current coils are in series with the mains and the potential coils are connected across to the third main. The arrows showing the assumed current and voltage directions have been so taken that both meters will read positive for delivered power.

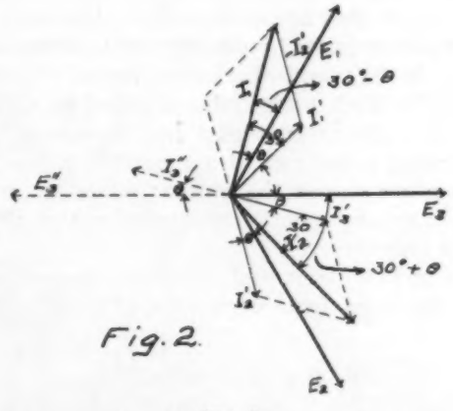


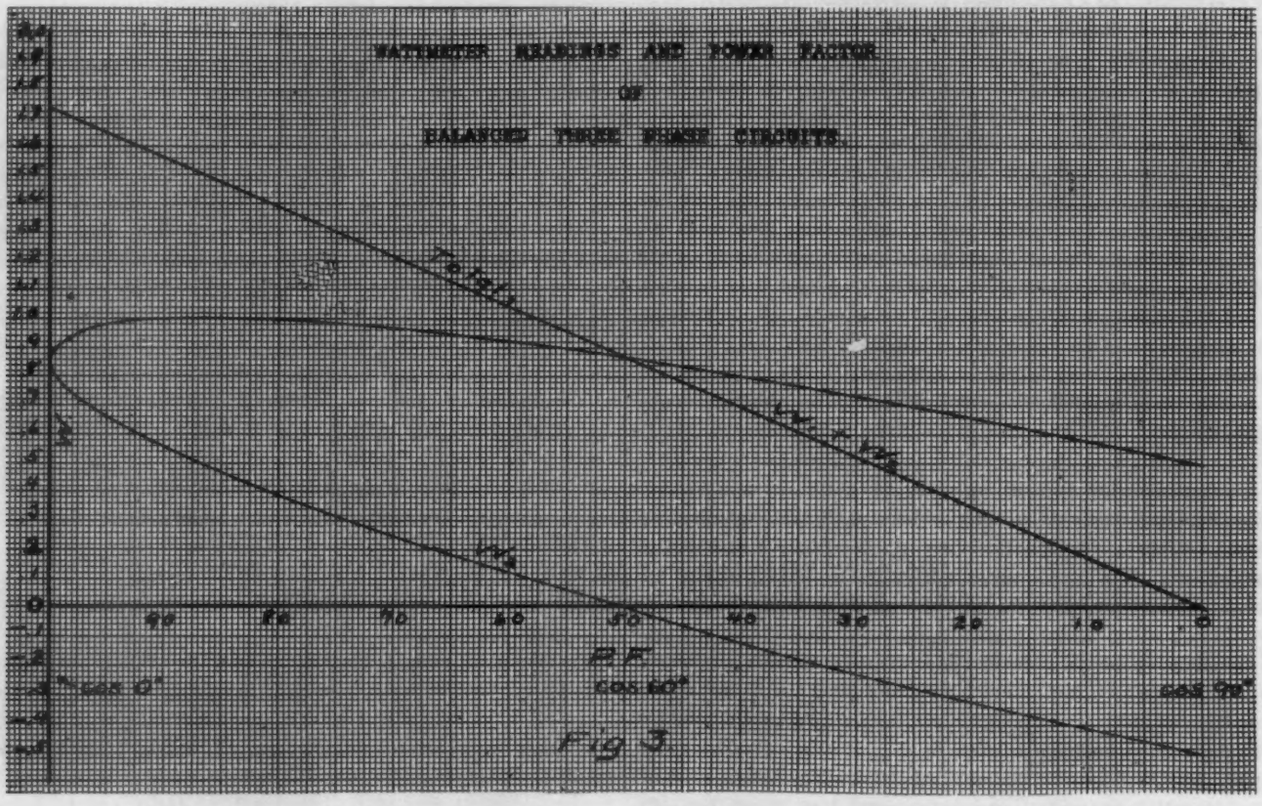
Fig. 2.

Fig. 2 is the corresponding clock diagram. It will be noted that the vectors, E_2 and I_2 are reversed

as they were so taken in the delta load mesh of Fig. 1. Assuming a balanced load, E_1, E_2 and E_3; and I'_1, I'_2 and I'_3, are equal, respectively, hence the vectors, I_1 and I_2 make angles of 30° with I'_1 and I'_3. Let the angle of lag be θ. With a balanced load this will be the same for all three phases; consequently, the phase difference of E_1 and I_1 is $30° - \theta$; and that of E_2 and I_2 is $30° + \theta$. Hence the power measured by W_1 is

$$W_1 = E_1 I_1 \cos (30° - \theta) \text{ or } E_1 I_1 \cos (\theta - 30°) \ldots . (1)$$

and by W_2,



$$W_2 = E_2 I_2 \cos (\theta + 30°) \ldots . (2)$$

These equations are plotted, assuming unity values of current and voltage in Fig. 3 with cos θ or power factor as abscissa. It will be noted that the behavior of W_2 now becomes clear. It decreases in value with the power factor becoming zero at 50per cent P.F. where θ is 60°, and thereafter negative for larger values of θ. With a non-inductive load or unity P. F., the meter readings are equal and their sum indicates the delivered power; at 50 per cent P. F., one is zero and the other shows the power; while at zero P. F. the readings are equal and opposite and the entire power is reactive.

The power factor and corresponding phase angle may be obtained from equations (1) and (2) as follows:

By composition and division,

$$\frac{W_1 - W_2}{W_1 + W_2} = \frac{E_1 I_1 \cos (\theta - 30°) - E_2 I_2 \cos (\theta + 30°)}{E_1 I_1 \cos (\theta - 30°) + E_2 I_2 \cos (\theta + 30°)}$$

Since the circuit is balanced, the E's and I's cancel and we may apply the formulae,

$$\frac{W_1 - W_2}{W_1 + W_2} = \frac{2 \sin \theta \sin 30°}{2 \cos \theta \cos 30°} = \tan \theta \tan 30°$$

or $\sqrt{3} \tan \theta$; from which,

$$\text{P. F.} = \cos \text{ arc tan } \sqrt{3}. (W_1 - W_2)/(W_1 + W_2) \ldots (3)$$

Numerical values may be obtained with greater facilitiy, however, by starting again with equations (1) and (2). Using the formulae,

$$\cos (A + B) = \cos A. \cos B + \sin A. \sin B$$

we have,

$$\cos (A - B) - \cos (A + B) = 2 \sin A \sin B$$

and

$$\cos (A - B) + \cos (A + B) = 2 \cos A \cos B$$

Whence,

$$\frac{W_2}{W_1} = \frac{\cos \theta. \cos 30° - \sin \theta. \sin 30°}{\cos \theta. \cos 30° + \sin \theta. \sin 30°}$$

Now $\cos 30° = \sqrt{3}/2$ and $\sin 30° = 1/2$.

Substituting,

$$\frac{W_2}{W_1} = \frac{\sqrt{3}/2. \cos \theta - 1/2. \sin \theta}{\sqrt{3}/2. \cos \theta + 1/2. \sin \theta}$$

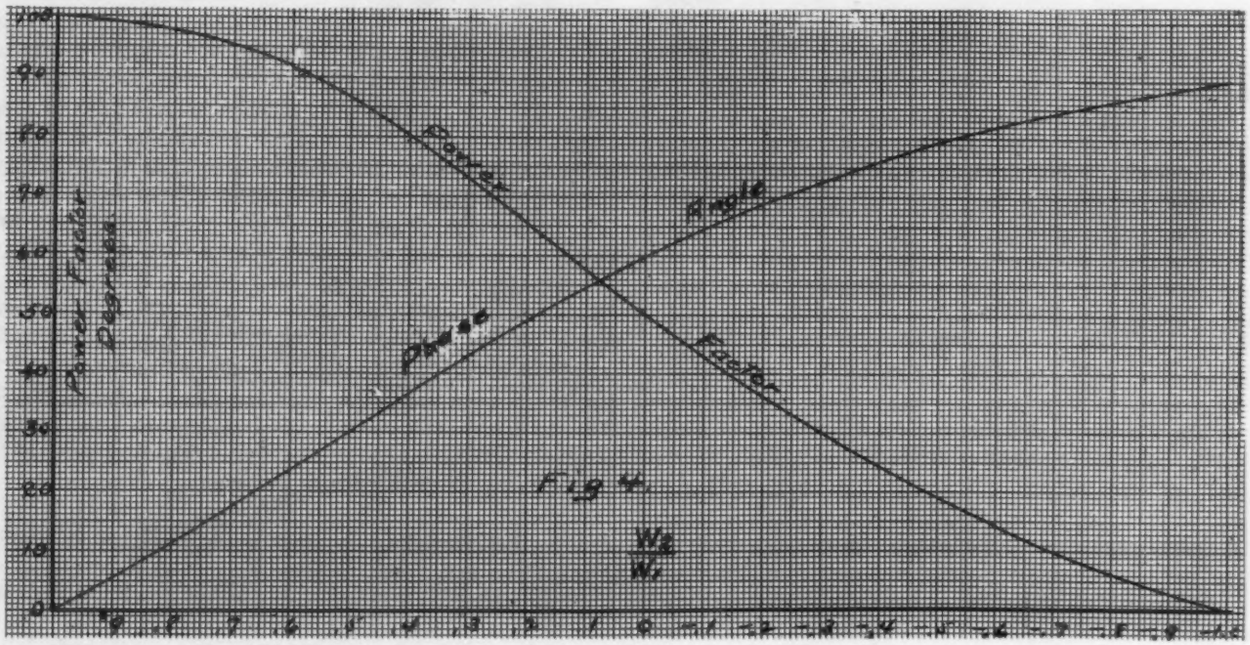
Dividing both numerator and denominator by 1/2. cos θ,

$$\frac{W_2}{W_1} = \frac{\sqrt{3} - \tan\theta}{\sqrt{3} + \tan\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

From Fig. 3 it is plain that the value (4) passes from + 1 to — 1 as the power factor varies. Therefore if values of (4) be assigned between these limits, corresponding values of θ may be determined. Placing (4) equal to x and solving for tan θ,

$$\tan\theta = \sqrt{3}.\ (1 - x)/(1 + x)$$

Whence,



$$\cos\theta = \frac{1 + x}{2.\sqrt{1 - x + x^2}},$$ which gives values

of the power factor directly, and wherein the assumed values of x may readily be substituted. The curve of Fig. 4 was derived in this manner. It gives the power factor corresponding to any value of W_2/W_1, which may be easily obtained by the slide rule from any given set of readings. The value of θ may be read off at the same from the "Phase Angle" curve should it also be desired.

When two single phase wattmeters are wired up on a circuit of unknown or varying power factor, the sign of the reading of W_2 may be in doubt. For example, an induction motor driven machine: In this case, if there is any way of loading the machine while the behavior of W_2 may be observed, the right connection may readily be seen. When load is thrown on the motor the power factor will rise, and hence if the reading of W_2 increases with the load, the power factor is known to be above 50 per cent. (See Fig. 3.) The same reasoning applies to polyphase integrating watthour meters. In this case the two elements should be tried separately to see which disk revolves the slowest—W_2. Having found W_2, the speed of revolution as load is thrown on can be noted and if it slows down the potential connection of this element should be reversed.

The curves of Figs. 3 and 4 readily afford a test of the balance of a three phase load. Let W'_1 and W'_2 be the readings of the single phase meters— (or number of revolutions of the watthour disks in a given interval)—and let W'_1 be the larger. If the circuit is balanced the value of $W'_2/(W'_1 + W'_2)$ (this test fails at 50 per cent P. F. as W_2 becomes 0) should equal $W_2/(W_1 + W_2)$ where W_1 and W_2 are the values found from Fig. 3 for the "apparent" power factor as determined from W'_2/W'_1 in Fig. 4. Where the difference is marked, the value of the power factor as obtained from Fig. 4 will be in error as these curves are based on balanced conditions. Unless the difference is rather large, a value close enough for most purposes will be obtained.

Should greater accuracy be desired, readings might be taken using each main as a neutral in succession and the power factors as obtained from each set of readings averaged. But on unbalanced load the true power factor is difficult to determine accurately, though the true power is easily and accurately obtained, allowing for instrument and personal errors.

ALASKA'S COAL DEVELOPMENT.

According to a statement in a report on the mineral resources of the United States issued by the United States Geological Survey, has been held back on account of the lack of legislation permitting the exploitation of the known extensive and valuable fields. In 1912 the commercial product of coal in Alaska amounted to only 355 tons. In addition 900 tons were mined under the direction of the Bureau of Mines for testing by the United States Navy. The imports of coal into Alaska amount to about 100,000 tons annually, but most of the transportation and manufacturing industries of the territory now depend on California oil for their fuel.

DIESEL ENGINE INSTALLATIONS ON BOARD SHIPS.

BY LARS JORGENSEN.

While the principles of the Diesel engine were invented more than ten years ago, the commercial success of this type of prime mover has but very recently been demonstrated. Judging from the rapidity with which the latest developments have taken place, this type of engine bids fair to supersede the steam engine on board ships—at least on ships running on certain routes.

As the Diesel engine has of late been able to show a marked superiority in economy over any form of steam driven engines, there is no reason why this type should not come to the front. Its construction, although more complicated than a turbine, is simple enough to insure reliability. In a Diesel engine many troubles inherent in the ordinary gas or gasoline engine are entirely eliminated. Only plain atmospheric air takes part in the compression, not a mixture of air and oil, as in the ordinary gasoline engine. Therefore, backfiring and premature explosion, which are the main causes of uncertainties in the operation of the gas or gasoline engine, making them more or less unfit say for use in a stand-by plant of an electric power system, cannot take place. The Diesel engine would therefore, seem to be especially well adapted and is in use in many medium size installations in Europe. It is always ready for work at a moment's notice, no boilers have to be kept under fire. It has a two and one-half to a three times higher fuel economy than the steam turbine.

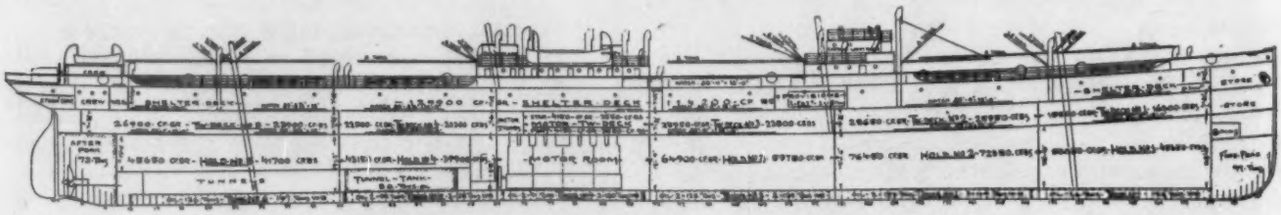
The performance taking place in the cylinder of a Diesel engine is briefly as follows: Pure atmospheric air is drawn into the cylinder and compressed during the return stroke, not to say, 150 lb. per sq. in. as is used in ordinary gas engine practice, but to about 500 lb. per sq. in. At this pressure the air has a temperature of nearly 1000 degrees F., which temperature is high enough to ignite the finely atomized spray of crude oil being forced into the clearance space of the cylinder at the end of the compression stroke. This injection of oil is kept on until about 1/9 of the working stroke has been completed, during which time a rapid combustion (not explosion) takes place in such a way that the initial pressure of 500 lb. per sq. in. is kept fairly constant until the inlet valve closes at 1/9 the stroke and the expansion commences.

The high compression of 500 lb. per sq. in. stimulates the combustion and the high efficiency obtainable with a Diesel engine is in a large degree due to this fact. The use of the high compression does away with all igniting devices, carburetors, etc., thus adding greatly to the reliability of the engine.

The development of the Diesel engine has been most active in Europe, both for marine and stationary purposes. There are several hundred thousand horsepower installed in electric power plants and on ships and over 300 of the latter are either now afloat or under construction. The "Selandia," the largest ship so equipped at that time, made its first trip between Copenhagen and Siam, 1½ years ago. It belongs to the Danish East Asiatic Steamship Company of Copenhagen, and a description of a few features of its power installation and its operation will be of interest.

The "Selandia" is a freight steamer of 7400 ton carrying capacity; it is equipped with two propellers, each driven by a Diesel engine capable of delivering 1200 h.p. to the shaft. The normal output, however, is only 1000 h.p. at 140 r.p.m., as this is sufficient to give the ship a speed of between 11 and 12 knots per hour, which speed is found most economical under the circumstances. Each engine is provided with 8 cylinders, working on the 4 cycle principle explained above, which gives two working cylinders per propeller at any one time. The cam shaft for operating the outlet and inlet valves has twice the number of cams ordinarily used, one set being used for running "ahead," and the other set for running "back." A small longitudinal movement of the cam shaft is all that is required to change the direction of rotation of engine and connected propeller. Compressed air is used for starting, the same as for all large gas engines, and when once started little attention is required. The crude oil for feeding the engines is stored away in the double bottom of the ship, a space which in ordinary steam ships cannot be put to any use. On account of the possibilities of the ship striking an obstruction some reserve is also carried in other parts. On the trip across the North Sea the engines used 10 tons of oil every 24 hr., including all auxiliaries, while a steamer under the same conditions would have used 40 tons of coal. At the West India dock in London the pilot called for 81 maneuvers of the engine inside an hour, which were answered with greatest exactness to the astonishment of several English ship builders who watched the performance of the ship.

An ordinary steamer running on the route between Copenhagen and Siam, coals at several places en route. It must pay higher prices as it proceeds away from England, as all the coaling stations are supplied with English coal, but the "Selandia" is able to take enough crude oil on board at Singapore, where oil is cheapest, to make one round trip. This circumstance represents another big saving, and close figuring gives the result that the Diesel engines save nearly 70 per cent of the fuel cost on this route, besides much labor expense.



Cross-Section of Diesel Engine Ship "Siam" now on the Pacific Coast.

Another advantage, besides the smaller fuel cost and larger space available for cargo, is the cleanliness which goes with such an installation, also that there is no boiler plant to heat up the ship and cargo, which, especially in tropical climates, is of no small moment.

The maintenance is not expected to be abnormally high for all the moving parts are as simple as a steam engine. The first cost of the engine has been high, partly due to the fact that nothing connected with it was standard and partly because all parts have been made exceptionally strong in order not to take any chances, on what was more or less an experiment. These engines were made on the 4-cycle principle, because it is the oldest and most conservative principle, although it was known that the 2-cycle principle could be usel in Diesel engine design resulting in a much cheaper engine, even considering its somewhat lower efficiency. While this ship built by Burmeister & Wain, Copenhagen, was the largest afloat 1½ years ago, it has been followed by others nearly twice as large and the ultimate size is not yet known.

The Diesel motor ship "Siam," due to arrive in San Francisco harbor on January 5th on its first trip around the world, which also belongs to the Danish East Asiatic Steamship Company of Copenhagen, is a forerunner of a line of Diesel ships which this company intends to put in regular service between ports in northern Europe and the Pacific Coast just as soon as the Panama canal is open for traffic. The "Siam" was built by Burmeister & Wain, Copenhagen, and has a freight carrying capacity of 9400 tons. The overall length is 410 ft., the width 55 ft., and the draft 27½ ft. It is provided with two eight-cylinder engines of 1600 indicated horsepower each. Each cylinder is 590 millimeter in diameter, the stroke is 800 millimeter, and the speed is normally 11½ knots.

The United Steamship Company of Copenhagen is at present building two ships of 13,000 tons freight carrying capacity each. One, the "California," is to be equipped with Diesel motors, and the other with a steam engine of equal horsepower. This is being done in order to find out in a practical way the actual economy of a Diesel motor ship compared with a steamship. The results from these tests will guide the company in deciding upon its future policy and especially as an aid in finding the economy possible in replacing steam engines with Diesel motors in existing steamships. The comparison will also prove useful in deciding upon the routes best adapted for steamers and for Diesel motor ships respectively.

Whether or not a Diesel motor will be a serious competitor to the steam turbine for the generation of electricity in large central stations remains to be seen. So far, Diesel motors have not been made in very large sizes and as far as simplicity is concerned turbines will always be ahead of a Diesel motor. A Diesel motor while much larger in volume than a turbine of the same capacity, takes up about 30 per cent less floor space than does the steam turbine, together with its necessary equipment of boilers, and generates a kilowatt-hour at a lower cost.

Some day these facts may induce large manufacturing concerns to develop a type of large size Diesel motors adapted for use in large central stations, but at the present time the single steam turbine has no competitor in this class of business.

The growing use of electricity and gas for power purposes in the oil fields is causing a gradual diminishing of the quantity of oil used in that field for fuel.

British Columbia mining dividends for the first nine months in 1913 amounted to a sum, paid out in the Kootenay and Boundary districts alone, of $1,654,875, or nearly $500,000 more than the companies in the same districts paid out during the entire year of 1912.

LIFE AND SERVICEABILITY OF METAL FLUMES.

In reply to a circular letter sent to engineers of the U. S. Reclamation Service, requesting information relative to the life and serviceability of metal flumes, the Reclamation Record publishes the following compilation of replies:

The following questions were asked:

(a) Is the galvanizing proving generally serviceable?

(b) Is there any serious rusting of the metal body?

(c) Is the use of paint desirable?

(d) Is there much difficulty in keeping the joints water-tight?

(e) What depth of clearance do you allow above the water line?

(f) Does sand seriously cut the flumes where the velocity is high?

(g) What maximum limit of velocity (ft. per sec.) in sandy or silty waters should be adopted?

Project.	Type, etc.	Age in Years.	Replies to above questions: (a)	(d)	(c)	(b)	(e)	(f)	(g)
Orland		3	Yes	No	No	Yes	6"		4
Uncomphagre[2]	Maginnis	4	Yes[3]	No[3]	No	Little	6"-12"	Yes	5
Boise		4	Yes	No	No	No[5]	2"-6"	No	5
North Platte	Hess (Am. Ingot Iron.	1-3	Yes	No	No[4]	No[6]	4"-6"	No	6-8
	Maginnis	4	No	Yes	Yes	Yes	4"-6"	No	
	Galvanized.								
Carlsbad	Maginnis		Yes	No	No	No	6"		
Belle Fourche	Maginnis		Yes	No	No[4]	Little	2"-3"		6
Shoshone	Maginnis	1	Yes	No	No	No			

[1] At seasons when temperature varies widely during 24 hrs.
[2] Provisional report pending better examination of flumes.
[3] Some sections have failed. Probably not general.
[4] Bolts, nuts, etc., should be painted.
[5] Temperature changes make it necessary to tighten joints each season.
[6] Not if joints are caulked with fiber cement. For riveted joints, yes.

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Changes of advertising copy should reach this office ten days in advance of date of issue. New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advanace of date of issue.

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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

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A Prosperous New Year

Stepping across the threshold into the immensity of the New Year, with its full measure of working days awaiting the performance of deeds, the Journal would pause, reach out and grasp your hand with the pressure of true friendliness, to wish you A Prosperous New Year. Then, urged by our common purpose—the prosperity and progress of this last great West—to press on again together.

That which constitutes your idea of prosperity is the good we have wished you, whether increased business, or whatever it may be. There is no limitation; we have wished you the realization of your own conception of prosperity, and would aid you, if possible, in attaining that end.

The outlook for 1914 is more promising. The year comes to us to encourage and finds a people receptive to its utmost intent.

A period of trial and adjustment to change is about us. The business waters, agitated and disturbed, are to have the oil of enterprise, determination, resourcefulness and proper adjustment poured upon them. The passage will again be made smooth.

With the good of all a common and desirable aim, selfish seeking should be subordinated, and such successful progress made in our endeavor that this increased prosperity will early be attained.

A Prosperous New Year.

Lighting Methods

Lighting has existed at least longer than man, but was generally haphazard, without method and uncontrolled. Even the sunlight was uncertain and the method of the moon a seeming madness. The starlight was spectacular on occasion, but save as a guide and an inspiration, knew no other value.

Seated close by a fire for warmth our forefathers found they could prolong the day, for artificial light though flickering and uncertain was the nightly accompaniment of the camp fire's heat.

The man who plucked the first brand from the fire and held it aloft, perhaps to obtain a better view of some wild animal which affrighted hurried back into the darkness, was the first to show method in lighting and away down the ages, more and more method has been introduced.

The miner making a cup of his hands so that they formed a reflector, and holding the candle low down to keep the light from his eyes was employing lighting methods—engineering illumination that more satisfactory results might be obtained. So also did our mothers' as candle or lamp in hand they shielded the light from our sleeping eyes. The same methods may be employed for entirely different results.

Our forefathers, the miner and our mothers, all illuminating engineers. Building up through observation and experience, necessity and usage, the methods which were later to form the basis of a most important science.

Method suggests the manner of accomplishment; that which has been done before and so may be done again. It does not necessarily treat of a science as such, but records the application of the principles in-

volved; the purpose accomplished. It is on such a basis that practical information may be readily imparted and it is in this manner that this new department of Journal service will be of value to our readers.

Lighting methods multiply rapidly and improve both as regards effectiveness and appearance. New installation typical of the most recent developments—the application of the latest laws, discovered by research—will if properly and promptly recorded make for progress and improvement, both as regards business and in the results obtained.

Lighting methods starts auspiciously, its growth should be interesting and rapid, and its maturity early.

Conservation by Wise Utilization

The fate of the West depends upon the battle between the spirit of achievement and the spirit of hindrance. The men who do things, those who blaze the trails of progress, are opposed by a horde of camp-followers, who would stifle all initiative and kill all ambition.

In no field has hampering legislation been more keenly felt or are its probable results more disastrous than in the development of the great hydroelectric resources of the West. Yesterday's poetic fancy that the silence of these solitudes was broken only by the dashing spray of tumbling torrents may charm the ear and please the eye, but it does not meet to-day's stern reality in feeding the mouths of the unemployed mobs in the cities that now occupy the sites of these former solitudes.

How the development of water-power reacts in developing the country is admirably told elsewhere in this issue by Frank G. Baum. The railroads have so concentrated people in cities that the problem of living in this modern world is the problem of finding room in it. This the transmission lines make possible by furnishing to the farm those advantages and conveniences which constitute the chief attraction of city life. They thus tend to reverse the direction of population flow.

We fully recognize the evils of a development which exploits the needs of the people. But we firmly believe that the Forest Service, in seeking to avoid the Charybdis of unwise development, has steered into the Scylla of non-development. Water power is not diminished by use nor conserved by non-use, as is logically proven on another page by W. V. N. Powelson. It renews itself perpetually and is wasted only when not used.

In trying to safe-guard the interests of the public the Forest Service is performing a noble duty. But can rates be reduced by virtually forcing the expenditure of an extra $75,000 to build a siphon to keep water off from government land? Is the fact that Federal property is crossed by a few feet of flume or a few acres flooded from a reservoir sufficient to justify a perpetual option for governmental purchase of a great transmission system? Do not the very stockholders of a corporation constitute an important part of the public whose interests are to be protected? Safe-guarding the interests of one part of the public by confiscating those of another is contrary to the established principle of American government.

The whole country is now suffering from the continued governmental attacks against legitimate business interests. All industry has been paralyzed by the wanton destruction of confidence in their stability. Distrust of the trusts is the reagent which has precipitated hard times from the solution of normal business conditions. Just as a horse is broken to the will of its master, so should the trusts be broken to the will of the people. But just as a high-spirited animal is worth far more than one broken in body and in spirit, so should men of spirit and ability be encouraged in their efforts which redound to the general good of society.

The Spirit of the Hive

The spirit of the hive finds its expression in co-operative service. Maeterlinck tells us in his Story of the Bee that "the bee is above all and even to a greater extent than the ant, a creature of the crowd." Isolate the bee and death results from sheer loneliness. To the bee existence without aim is also undesirable; there is a desire to fill its place, active industry and even self-sacrifice for those who may come after. In the hive the individual is nothing and existence conditional only upon present useful co-operative activity.

That the pride of toil be equally distributed is also as inherent principle of the hive, and that every achievement be anonymous and common to all. A truly "fraternal" spirit is expressed by these sisters of toil. None does all the work, but each contributes her share to the completion of the task they so willingly and industriously undertake for posterity.

It would be difficult to say why it is that the bee balances the future against the present, and perhaps blindly, chooses the unseen for that which is, but it is certain that it finds its expression in this spirit of the hive which being interpreted means—Co-operation.

Because the bee works on a different community basis from that of man it is perhaps unwise to too hastily deduce from our observation of the hive, conclusions that apply to ourselves, but this spirit of co-operation is continually proving its importance.

All of our lives meet at common centers of interest and it is from these that we can commence, whether this be in connection with our neighborhood, industrial or business life.

There exists in the electrical industry a sincere expression of this spirit. This idea of reciprocity, working together, co-operation.

Successful co-operation cannot be based upon the self interest of either party—for it takes two to co-operate. To let the other fellow do all the co-operating is to inbreed a parasite. There must obtain mutuality and a common cause. Properly expressed others are stimulated to similar action, and when all work for the same end, co-operation, then a code of conduct, becomes irresistible and accomplishment easy.

In the electrical industry all are aided each by the efforts of others. Such interdependence is a plea for the fullest co-operation that the interests of all be best served; the hurt of one is an injury to the rest and to the future years. Let us express the spirit of the hive.

PERSONALS

ITEMS FOR THIS DEPARTMENT ARE SOLICITED FROM ALL READERS

H. W. Jacobs, electrical contractor, Santa Rosa, is at San Francisco.

Neil C. Hurley, Hurley Machine Company, Chicago, Ill., is at San Francisco.

J. B. Lukes, representing Stone & Webster Company, is at Portland, Oregon.

F. V. McAvoy, Reno Electric Works, is a holiday season visitor at San Francisco.

C. V. Schneider, Electric Supply Company, Sacramento, was at San Francisco last week.

Chas. Fraser, of Fraser Bros., electrical contractors, San Jose, was a recent visitor at San Francisco.

A. B. Saurman, Pacific Coast manager for the Standard Underground Cable Company, is making a month's trip East.

G. Anderson, salesman Electric Appliance Company, is at San Francisco for the holidays, having come in from Arizona.

P. T. Hanscom has resigned as general superintendent of the Great Western Power Company, San Francisco, and left the early part of the week for the East.

N. C. Wolfe, assistant purchasing agent, Mt. Whitney Power & Electric Company, was at San Francisco recently on company business.

H. C. Goldrick, Pacific Coast manager for the Kellogg Switchboard & Supply Company, left San Francisco this week for an Eastern trip.

O. W. Lillard, manager Gould Storage Battery Company, San Francisco, expects to leave shortly for a business trip East. He will visit the company's main office in New York while away.

J. A. Doose, formerly with the municipal lighting plant at Tacoma, Wash., has been made superintendent of the new Tule River power plant of the San Joaquin Light & Power Corporation.

J. Dalziel and **J. Sayres,** electrical engineers with the Midland Railway, England, are making an inspection of the various Pacific Coast electric railway systems, now being at Los Angeles.

Hal Lauritzen, manager western division, Holophane Works of General Electric Company is at Chicago and will visit the company's head office at Cleveland, Ohio, before returning to San Francisco.

S. Glen Vinson, secretary and general manager of the Ideal Electric & Manufacturing Company of Mansfield, Ohio, has been at San Francisco perfecting arrangements for his company's Pacific Coast office.

Paul B. Wilson, formerly district agent of the San Joaquin Light & Power Corporation at Paso Robles has succeeded **Geo. W. Bernhard,** resigned, as agent at Madera. **O. A. Kommers** has succeeded Mr. Wilson at Paso Robles.

L. Wood Davis, formerly traveling salesman with the Intermountain Electric Company of Salt Lake City, and at present with the Westinghouse Lamp Company at their Butte office, is visiting in Salt Lake City during the holidays.

Robert H. Parker, local manager Butte office, General Electric Company, is visiting in Salt Lake City during the holidays. Mr. Parker was formerly local manager of the Salt Lake office, and married a daughter of Salt Lake City's veteran editor, Judge C. C. Goodwin.

H. B. Miller, chairman Oregon Hydroelectric Commission, has named for his executive committee the following: **Judge Thomas C. Burke,** chairman; **John McCourt, W. D. B. Dodson,** and **H. L. Vorse.** The committee will meet immediately to direct the investigations of the commission.

Samuel S. Arentz, chief engineer Salt Lake & Utah Railroad Company, who has been in charge of construction since the beginning of work in September, 1912, has resigned and will remain in Salt Lake and engage in private business. Mr. Arentz has been with the firm of A. J. Orem & Company for eight and one-half years, serving as engineer and superintendent in the Silver City, Bingham and Yerington districts, and as chief engineer, Nevada Copper Belt Railway, where he had charge of construction of forty-two miles of line.

OBITUARY.

H. L. Metcalf, late assistant general manager of the Pacific Electric Railway Company, died at his home in South Pasadena on Thursday, the 24th of December, 1913. His funeral on Saturday, the 27th of December, was largely attended. As a mark of respect the Pacific Electric offices were closed during the progress of the funeral.

MEETING NOTICES.

Utah Eectric Club.

The regular luncheon of the Utah Electric Club was held on Friday of this week on account of Christmas falling on the regular meeting day, Thursday. The program committee had provided no regular speaker for this luncheon, but instead had arranged for a day of jollification. A team from one of the local vaudeville houses provided a varied program, which was interspersed by songs and stunts by the members of the club.

Electric Development League of Alameda County.

The regular monthly lunch of the Electric Development League of Alameda county was held in Oakland on December 27th, Co-operation in bettering present conditions and relations between consumer, contractor and dealer, was the subject of a general discussion opened by A. E. Rowe and F. Pinger. A. H. Halloran spoke on Jovianism and also on the advantages of the "electric page." Geo. B. Furniss, president of the league, presided at the meeting.

Joint Meeting Portland Sections A. I. E. E. and N. E. L. A.

Local sections of the above national bodies will hold a joint meeting at 8 p. m. on January 6, 1914, in the Hawthorne building, Portland, Oregon. A paper on "Duplex and Quadruplex Telegraphy" will be presented by B. S. Durkee, chief operator Postal Telegraph Cable Company, Portland, Oregon.

One of the N. E. L. A. Lecture Bureau papers on "Hydroelectric Developments on the Pacific Coast" will also be presented and will be illustrated with lantern slides. Mr. G. P. Nock will preside at the meeting.

TRADE NOTES.

The Washington Water Power Company, Spokane, awarded contracts to the General Electric Company for four transformers for its Long Lake plant. These will be 6500 k.v.a. each.

The calling of the five-day strike of 15,000 employes of the General Electric Company, which was called off on December 1st is stated by the strike committee to have been largely due to a mistake. The committee makes the further statement that there was no intentional discrimination in laying off two employes, that the company is not antagonistic to organized labor and that they do not question the right of the company to reduce the force when necessary in such manner as may be deemed best by the management. The company agreed to place as large a number of employes as conditions will permit.

The Westinghouse Electric & Manufacturing Company reports the receipt of the following orders: Salt Lake & Utah Railway Company, Salt Lake City, Utah: Six 250 kw:. 750 volt, d.c. 3-phase, 60 cycle, 1200 r.p.m. a.c. self-starting rotaries mounted on a common bedplate for operation in series

at 1500 volts d.c.; six 150 k.v.a. 44,000 to rotary voltage, single-phase, 60 cycle, O. I. S. C. transformers with triple secondaries to operate any two or three rotaries at one time, and two switchboards for the above, consisting of seven panels each, also for the Seattle Lighting Company, Seattle, Wash. Two 110 kw., 250-125 volt, 3-wire, 260 r.p.m. compound wound engine type, Type Q generator, complete with field rheostat and balance coils.

The James Kennedy Construction Company, T. D. Hanley manager, Portland, Ore., awarded the contract for a power drilling equipment at St. Helens to Otto B. Goldman, machinery contractor, 303-4 Lewis building. The equipment installed consisted of one 22 h.p. Stover oil engine and an 8x8 Ingersoll-Rand compressor operating at 182 r.p.m. and 110 lb. pressure. The drills used were Ingersoll-Rand 32 lb. and 30 lb. Harzog. Mr. Goldman also reports the sale of two pumps to the Northwestern Electric Company of Portland, Ore., one single stage pump for a capacity of 80 gal. per min., against a head of 110 ft. and the other 3-stage for a capacity of 200 gal. per min. against a head of 200 ft. Jackson centrifugal pumps direct connected to General Electric motors are being used. They will go in the new Pittock Block. Contracts for the new pumping machinery for the city of Linnton, Ore., Mr. Louis C. Kelsey of Portland, engineer, were also awarded to Mr. Goldman. This will consist of two pumps each of 75 gal. per min., one of which will pump against a head of 520 ft., and the other against a head of 585 ft., the highest in Oregon. In order to make them entirely automatic, Cutler-Hammer controllers are being used at the pump house, together with float switches and accessories at the reservoirs, connected to the controls by control wires. An excellent by-pass arrangement is being provided for each pump to furnish high pressure when needed for fire protection. Westinghouse motors will be used.

OREGON HYDROELECTRIC COMMISSION.

General investigation of the subject of water power and the development of electric energy was mapped out by the new Oregon Hydroelectric Commission, at its first meeting held at the Portland Chamber of Commerce. The commission was created as a voluntary body last June when the commonwealth congress met at the University of Oregon at Eugene to consider the general welfare of the state. In the main, the commission's plan is to encourage the upbuilding of industry depending upon electric power. To that end, a thorough study of engineering, cost of energy, technical questions of metallurgy and all the problems incidental to the subject will be probed and the results made public in expert reports.

H. B. Miller, former consul-general to China, is chairman of the commission and presided at the conference. Judge Thomas C. Burke, collector of customs, was appointed vice chairman and W. D. B. Dodson, acting secretary. Committees will be appointed on a dozen different subjects, and this task will be undertaken within the next few days so the active work of the commission may go forward with rapidity.

One committee will investigate the present power laws of Oregon to find out whether or not they are discouraging to industries. Another will study power development in its relation to navigation and co-operate with the organization of local legal districts to assess members for development expense and work with the federal government to divide the cost of power development and navigation.

Still another will investigate metallurgical possibilities of the Oregon power sites in the reduction of ores. In this connection, the question of importing iron ores from China for reduction here will be looked into.

The possibility of making nitrates for fertilizer by the agency of this electric energy likewise will be studied and a committee will look into the financial question as it bears on power development—what capital demands and why it objects, if it does object, to such avenues of investment. Other committees will investigate legal matters connected with interstate use of power sites, the use of electricity on the farm, the making of charcoal from stumpage on logged-off land, the effect of water power industries on the labor situation and the economic relation of power development upon civilization generally.

Some engineers have estimated that Oregon now has 3,200,000 potential horsepower in its waters, though others have said 6,000,000 is nearer the amount. The state engineer will co-operate with the commission in learning as nearly as possible, what potential horsepower is available.

EXAMINATION FOR INSPECTOR OF MECHANICAL AND ELECTRICAL ENGINEERING.

The United States Civil Service Commission announces an open competitive examination for inspector of mechanical and electrical engineering, for men only, on January 21, 22, and 23, 1914. From the register of eligibles resulting from this examination certification will be made to fill a vacancy in this position, at $2000 a year, in the office of the supervising architect of the treasury, and vacancies as they may occur in positions requiring similar qualifications.

The duties of the position consist of inspecting and testing the mechanical and electrical equipments entering into the modern government or office building. It is desired that applicants shall have had practical experience in the design, construction, and inspection of work in the following branches of mechanical, electrical, and sanitary engineering. Heating and ventilating apparatus, plumbing, water supply and drainage, conduit and wiring work, elevators, vacuum cleaning systems, and electric generating plants. The duties of the position in which the vacancy exists at present will necessitate constant travel on department business.

Under an act of congress applicants for this examination must be examined in the state or territory in which they reside and must have been actually domiciled in such state or territory for at least one year previous to the date of the examination.

NEW CATALOGUES.

(Under this heading attention is directed to catalogues and bulletins representing the latest information upon the subjects treated. The latest developments are always in advance of the most up-to-date text books. Readers are urged to write direct to the publishers for these catalogues and bulletins, which, unless otherwise stated, are available for free distribution.)

The Automatic Electric Washer Company, Newton, Iowa, is mailing an illustrated descriptive booklet on their make of electrically operated washing, clothes wringing, and ironing machines.

Macbeth, Evans Glass Company, Pittsburg, is distributing a portfolio of plates illustrating their new line of portable lamps. It is uniform in size with their regular catalogue and is entitled Electric Lamps of Distinction.

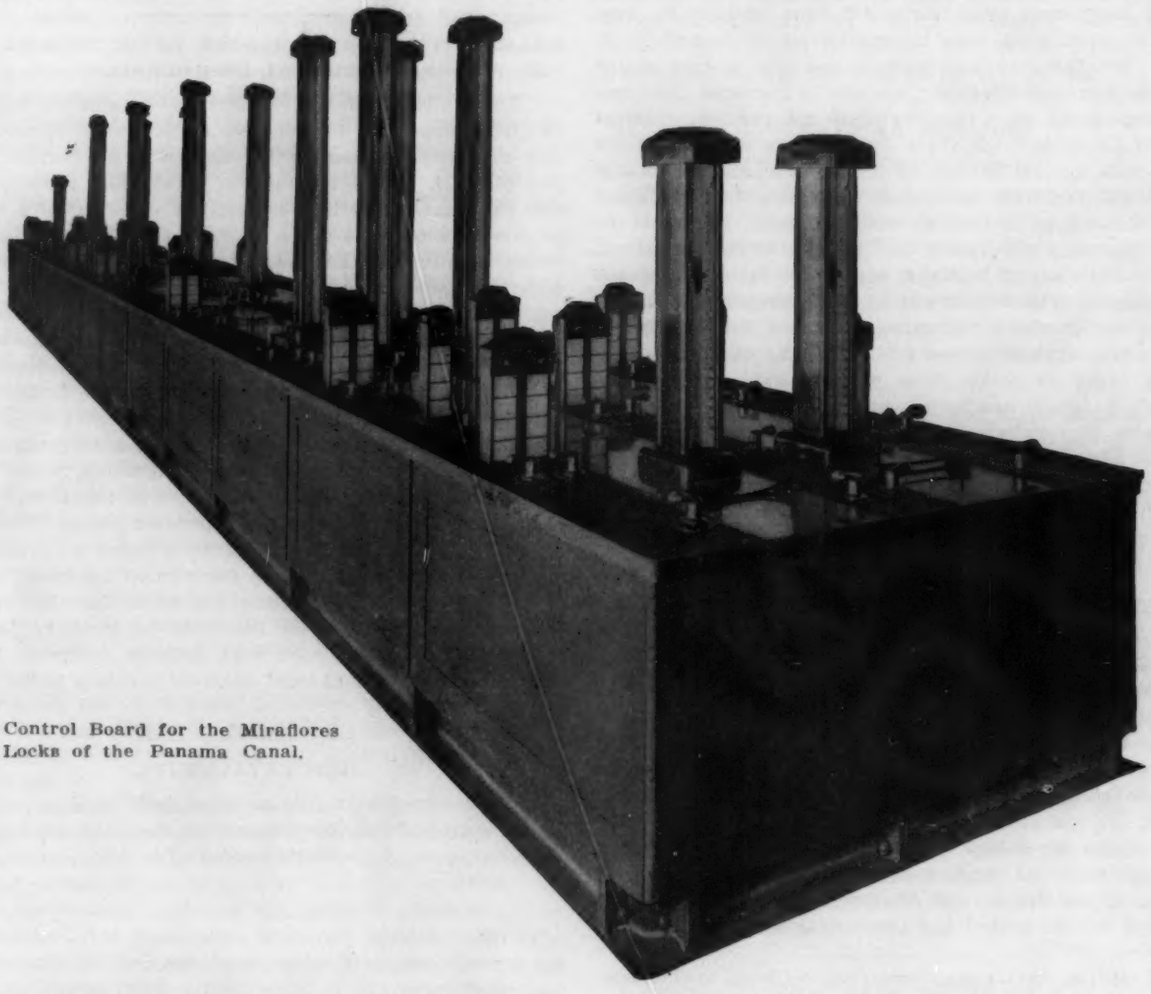
Bulletin No. 531-H issued by the Geological Survey is a report of an investigation of the Horseshoe Bend and Jerusalem Valley coal beds on Payette River, Idaho. It may be secured by addressing Director of the Geological Survey, Washington, D. C.

The Electric Storage Battery Campany has issued a beautiful "Silver Anniversary Book," which gives a synopsis of the company's history since its organization and a description of the various manufacturing departments of the works. Printed in silver and black and bound in covers of gray this brochure is particularly attractive, while the text on the building up of an industry is of exceptional interest.

INDUSTRIAL

CENTRALIZED CONTROL SYSTEM FOR PANAMA CANAL LOCKS.

The electrical specification, design and manufacture of the Panama Canal centralized control system may properly be regarded as one of those undertakings which, from an engineering standpoint, not only arouses a lively interest but also presents an opportunity for much valuable instruction. The complete operation of the canal locks, terminals and auxiliary equipment utilizes electrical energy throughout, with the present exception of the Panama railroad, the electrification of which is under contemplation.



Control Board for the Miraflores Locks of the Panama Canal.

The specifications for the entire generating, lock controlling and distribution system for operating the Panama Canal were prepared under the supervision of Edward Schildhauer, electrical and mechanical engineer, Isthmian Canal Commission, assisted by a staff of able electrical engineers, including C. B. Larzelere, who was closely identified with the lock control problems, and W. R. McCann with the generation and distribution of power. These specifications exhibited great care and painstaking engineering. They contained every safeguard that expert engineers could suggest, were exact and explicit in regard to the results required, yet gave proper range in the details of accomplishment.

All of the lock machinery motors, control panels, centralized control boards, power station generating apparatus, switchboards, transmission line substation equipments, coaling stations, and practically the entire electrical equipment for the wharf terminal cranes and for the extensive permanent repair machine shops were manufactured by the General Electric Company.

The power system for the operation of the locks, towing locomotives, lights for the locks and buildings, and motors not directly connected with the lock control, is composed of:

A 7500 k.v.a., 2200 volt hydroelectric power plant at the Gatun Dam;

A 4500 k.v.a., 2200 volt Curtis turbo-generator electric power plant at Miraflores for emergency, lately used to supply power for construction work;

A double 44,000 volt transmission line across the Isthmus, connecting Cristobal and Balboa with the two power plants;

Four 44,000, 2200 volt substations, stepping down at Cristobal and Balboa, and up or down at Gatun and Miraflores, depending on which of the two plants is supplying power;

Thirty-six 2200-240 volt transmission stations for power, traction and light at Gatun, Pedro Miguel and Miraflores locks;

Three 2200-220-110 volt transformer stations for the control boards at the locks;

Stations at Cristobal and Balboa for coal handling plants, machine shops and dry docks.

The instrument and control board for the Gatun generating station is of natural black slate, as are all the

switchboards for the power system. It is totally enclosed by means of grille work with doors at each end. The switchboards for the transmission line substations are of the vertical type, with control apparatus and mimic connections symmetrically arranged on the middle section of the panels. The rear of the board is enclosed by means of grille work with doors at each end.

Current for the lock machinery and towing locomotives is transformed from the 2200 volt system in the immediate vicinity of where it is used. There are a total of thirty-six transformer stations, for all locks, each containing duplicate 200 k.v.a., 3-phase 2200-240 volt transformers for power and one single-phase 25 k.v.a., 2200-220-110 volt transformer for lighting. The stations, normally fed from the 2200 volt buses in the 44,000-2200 volt substations, can also be operated from the power plants; the stations at Gatun locks from the Gatun hydroelectric station; and the stations at Miraflores and Pedro Miguel from the Miraflores emergency steam plant.

Control House at Gatun.

To give an idea of the number and sizes of motors to be controlled in operating the lock machinery, the following table is interesting:

Machines and Operation.	Motors each Machine. and h.p.	Number of Motors Ga-tun.	Ped. M.	Mira.	Tot	Total h.p.
Miter gate, moving, each leaf.	1-25	40	24	28	92	2300
Miter gate, miter forcing....	1- 7	20	12	14	46	322
Fender chain, main pump.....	1-70	16	16	16	48	3360
Fender chain, operating valve	1- ½	16	16	16	48	24
Rising stem gate valve.....	1-40	56	24	36	116	4640
Cylindrical valve.....	1- 7	60	20	40	120	840
Guard valve	1-25	6	6	6	18	450
Auxiliary culvert valve.....	1- 7	4	4	4	12	84
Totals		218	122	160	500	12020

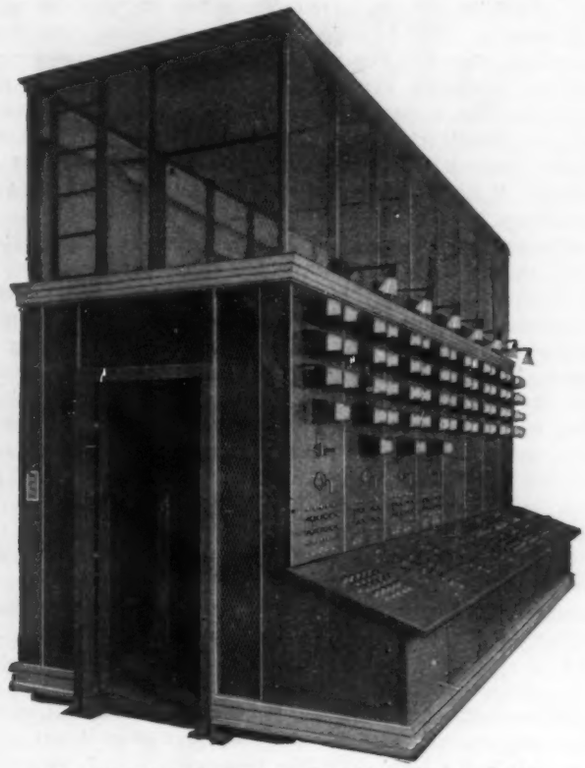
There are many motors not included above, as, for instance, those for the spillway gates, for the hand rails on the mitering gates and for the sump pumps.

The motors are started and controlled by contactor panels located near them, the contactors of which handle the main motor currents. These contactors are controlled from the central control house. The smaller motors, including those for cylindrical valves, auxiliary culvert valves and miter forcing, are started by being thrown directly on the line. Two double-pole contactors are used, one for forward and one for reverse. In the case of larger motors for miter gate moving, rising stem valves and guard valves, a starting point with resistance in two legs of the three-phase circuit is provided.

Location and Operation of Lock Machinery.

From an operating standpoint the machinery was placed below the coping of the lock walls, thus affording a clear space for maneuvering ships and protecting the apparatus from the weather without erecting numerous houses.

The mitering gates consist of two massive leaves pivoted on the lock walls which operate independently of each other. A pair of gates is located where each change of level occurs and divides the locks into 1000-foot chambers. In addition to these gates, at lake and ocean ends are duplicate pairs of gates used as guard gates. To handle the vessels of various sizes with the minimum use of water, mitering gates of the same description as those above are installed, dividing 1000-foot locks into two compartments. These gates are termed intermediate mitering gates. When the mitering gates



Instrument and Control Benchboard for Gatun Hydroelectric Station.

are closed they are what might be termed clamped in this position by a device called a miter forcing machine.

Chain fenders are stretched across the canal in front of all mitering gates which can be exposed to the upper lock level and also in front of the guard gates at the lower end. These chains are maintained in a taut position when the gates behind are closed, and are lowered when the gates are opened for the passage of a ship. The chains are raised and lowered by a method similar to that followed in hydraulic elevators, with the additional feature that if a ship approaches the gates at a dangerous speed and rams into the chain, the chain is paid out in such a way as to gradually stop the ship before it reaches the gates. Lowering the chain for the passage of a vessel and raising it again after the vessel has passed is accomplished by two motors; one driving the main pump supplying water under pressure, and the other operating a valve which controls the direction of movement of the chain. These two operations are combined in one, each motor being stopped automatically by a limit switch when the motor has performed its function.

The filling and emptying of the locks is accomplished by three culverts, one in the middle wall and one in each

side wall, the flow of water being controlled by rising stem valves. They are located in the culverts at points opposite each end of each lock so that the culvert can be shut off at any desired point for filling a lock with water from above, or upstream, or for emptying it by allowing it to flow out and down to the next lock. Lateral culverts conduct the water from the main culverts, under the lock chambers, and up though openings in the lock floors.

Centralized Control and Indicating System.

As the flight of locks at Gatun, for instance, extends over approximately 6200 ft., and the principal operating machines are distributed over a distance of about 4000 ft., it can be readily seen that central mechanical transmission of control of machines would be almost impossible; and to control the machines locally would mean a large operating force distributed practically along the full length of the locks, which has invariably been the practice heretofore. Such a force would be difficult to co-ordinate into an efficient operating system. The situation therefore resolved itself into centralized electrical control, which reduces the number of operators, operating expense, and liability to accident. To accomplish this system of control, a control board for each lock was constructed which permitted having all control switches located thereon mechanically interlocked so as to minimize, if not entirely prevent, the errors of human manipulations.

The control boards are installed in control houses located on the middle walls at points which afford the best view of the locks, although this view is not depended on to know the position of the gates or other apparatus, as all are provided with indicators on the control board. The control boards are made approximately operating miniatures of the locks themselves, and are arranged with indicating devices which will always show the position of valves, lock gates, chains and water levels in the various lock chambers; and with the exception of such machinery as needs only an "open" or "closed" indication, the indications will be synchronous with the movement of the lock machinery.

The indicators were developed especially for this undertaking, and show accurately and synchronously every movement of the machinery to which they are connected, whether in the extremes of travel or at any intermediate point.

Water Level Indicators.

The specifications covering the water level indication required an accuracy of 1/20 of a foot or 1/10 of 1 per cent in actual water level. In the transmitters and receivers for the machines described previously, the rotors turn less than 180 degrees with an inherent lag of 1½ per cent between transmitter and receiver rotors in this distance, which obviously prevents this arrangement from being employed to give the water level indication.

It was found that if the rotors were revolved ten complete revolutions, the required accuracy could be obtained; but since this arrangement makes it possible for the rotors to be in synchronism every 180 degrees, or in twenty different positions for the entire travel, the indicators would not indicate correctly if for some reason the transmitter rotors were turned more than ½ revolution with the power off. Therefore, the required accuracy was obtained by two sets of transmitters and receivers, one set connected to a fine index in which the rotors make ten complete revolutions and the other set connected to a coarse index operating less than 180 degrees.

The fine index is a hollow cylinder carrying a pointer, the length of the cylinder being such that when an aluminum ball representing the coarse index, which can be depended upon for coarse indication, is within the limits of the cylinder, the reading of the fine index is correct within the limits specified. The scales are illuminated by lamps in both base and top caps of the indicator.

For water level indication, wells 36 in. square in the lock walls with communication to the lock by a small opening at the bottom of the well to dampen surges contain a welded steel box float, 30 in. square by 9 in. deep. A non-slipping phosphor bronze belt transmits the movement of the float to a sheave fitted with pins on the transmitter mechanism, the pins registering with holes punched in the belt. The sheave shaft is carried in ball bearings with oil cups for lubrication and drainage cocks at the bottom of the bearings.

The position of the miter forcing machine is not indicated by synchronous indicators, but its open and closed positions are shown by red and green lights and a mechanical indicator on the control board representing the machine.

The control boards are of the flat top benchboard type, 32 in. high by 54 in. wide, built in sections, with total lengths as follows:

Gatun	64 ft.
Pedro Miguel	36 ft.
Miraflores	52 ft.

The side and center walls of the locks are represented by cast iron plates and the water in the locks by blue Vermont marble slabs. The outer edge of the board is surrounded by a brass trim rail, and the sides are enclosed with steel plates which can be readily removed for inspection of the board. The control board is supported by a wrought iron framework resting on base castings, which are in turn supported on the operating floor of the control house.

The control switch handles are mounted above the surface of the board and operate through an angle of 90 degrees. They are provided with name-plates for the "open," "closed" and "off" positions. The space immediately below the flat top of the control board is occupied by the contact fingers of the control switches, mounted on the operating shaft, synchronous receivers and their cable connections. Connection boards are provided for the cables, which are led up from each side, as are buses for supplying current to the control switches, receivers and the lamps that illuminate the scales of indicators. The receivers, transmitters and lamps are operated at 110 volts, while the control circuits are 220 volts, both using 25 cycle alternating current.

In order to make it necessary for the operator to maneuver the control switch handles always in a certain order, corresponding to a predetermined sequence of operation of the lock machinery, and to prevent the operator in control of one channel from interfering with the machinery under the jurisdiction of the operator controlling the other channel, these control switches are provided with interlocks. The interlock system is essentially a bell crank mechanism, connecting the shaft of the control switch through a movable horizontal bar to a vertical operating shaft which can or can not move according to the relative positions of the interlocking bars and dogs.

Nearly two thousand special drawings were required in the fabrication, and there were also involved the following unusual quantities of materials.

Special slate bases	1,300
Small castings	160,000
Screw machine parts	1,200,000
Copper rod and bar—feet	58,000
Asbestos lumber—square feet	9,000
New patterns	650
New jigs, templates, tools, etc	625
Porcelain parts	18,000
Special bus supports	6,800
Gal. pipe (framework)—feet	21,000
Special gears	2,300
Special instruments	640
Miscellaneous sherardized pieces	300,000
Cases for boxing	4,150

The combined weight of the centralized control boards for Gatun, Pedro Miguel and Miraflores is about 39 tons. In their construction there is employed: More than 2¼ miles of interlocking rod; about six million feet of control leads—made up in 5 and 8 conductor cables; 732 indicator motors; 464 control switches.

NEWS NOTES

INCORPORATIONS.

SAN FRANCISCO, CAL.—Reliable Electric Company, capital stock $5000, has been incorporated by A. E. Cerf, J. B. Shlare and Bernard Zellensky.

LOS ANGELES, CAL.—Olston Electric Stove Company; $200,000; subscribed, $50. W. L. Rosa, C. E. Stoner, M. R. Lewis, et al., are the incorporators.

LOS ANGELES, CAL.—Magnetic Trolley Retriever Company, capital stock $500,000; subscribed, $5. J. W. Kays, F. L. Gilman, Louis J. Hembree, Fred L. Dorman, Verna T. Dorman, directors.

TUCSON, ARIZ.—The stockholders of the Cababi Mining Company, which operates the Cababi mines in southwestern Pima county, have organized a company under the name of the Arizona Power & Water Company, S. G. McWade being manager of both the Cababi and the new company. The purpose of the organization is to utilize the waters that flows down Cababi canyon in Rincon mountains. The capitalization of the new company is $5,000,000. The plans are to build a dam costing $3,000,000. Power will be generated for the operation of mines, mills and factories and water will be furnished for municipal and irrigation purposes.

ILLUMINATION.

MOLALLA, ORE.—A franchise for lighting this town was asked for by Mr. Burst of Aurora in the name of the Molalla Power Company.

PUYALLUP, WASH.—The council has accepted an electric lighting contract with the Puget Sound Traction, Light & Power Company.

LONG BEACH, CAL.—The board of public works has rejected all bids for installation of a lighting standard system in Pacific Park and has ordered the original plans modified.

SOUTH BEND, WASH.—A gas franchise has been granted to the Henry Pratt Company of Tacoma to build a plant, lay pipes and sell the product here. The plant will be in operation within two years.

BELLINGHAM, WASH.—Improvements costing approximately $8000 are to be made in the gas plant of the Puget Sound Traction, Light & Power Company according to the announcement made by Manager Leslie R. Coffin. The work includes the construction of a concrete foundation to support a steel holder tank.

SPOKANE, WASH.—Three machinery firms are now figuring on the cost of installation of an isolated plant for the generation of electrical energy for light and power at the municipal building and will submit their estimates to Commissioner Fassett, who was instructed to secure estimates for installing a separate plant.

BERKELEY, CAL.—Mayor C. D. Heywood presented an ordinance at the last meeting of the Berkeley council which provides that all light and power wires, with the exception of street car and local trolley wires, be installed in conduits under all permanently improved streets. This ordinance which has been referred to the city attorney, is another step in the city beautiful program under consideration by the Berkeley council.

SALT LAKE CITY, UTAH.—George D. Keyser, commissioner of parks and public property, gave the "kiddies" of Salt Lake City a treat on Wedensday evening by providing the first municipal Christmas tree. One of the large evergreens on the west side of the city and county building grounds was beautifully decorated with colored electric lamps and tinsel and the three surmounted with a large star outlined in incandescent lamps.

LOS ANGELES, CAL.—The railroad commission has rendered a decision reducing the wholesale rate on natural gas piped from the Kern county fields into Los Angeles county from 18c per 1000 ft. to 10c per 1000 ft. The commission fixes this as the rate at which the natural gas may be sold by the Midway Gas Company at the terminus of its line in Los Angeles county to the distributing companies which retail the product in Los Angeles city and surrounding municipalities. Based upon the amount of gas used, the reduction will amount to from $250,000 to $300,000 per year.

SALT LAKE CITY, UTAH.—Mayor Samuel C. Park of Salt Lake City announces that the new contract with the Utah Light & Railway Company for the supply of street lighting for a period of three years commencing January 1, 1914, has been approved by the city commission. The city has at the present time approximately 1100 street lights, 80 of which are connected by means of underground mains and the balance by overhead circuits. Under the contract just expiring the city paid a rate of $5 per lamp per month for 4-amp. luminous arc lamps. The new contract provides for the same system of illumination, but the rate is reduced to $4.75 for lamps in the underground district and $4.50 per lamp per month for lamps connected by overhead circuits. The new rates will effect a saving to the city of approximately $6600 per year, and Mayor Park states that this amount will be expended for additional lights, which are now badly needed.

TRANSMISSION.

LOS ANGELES, CAL.—Plans are being made by the Tulare County Power Corporation for the expenditure of $80,000 for extension of the service in the district bounded by Exeter on the north, Sausalito on the south, Windsor on the east and Tulare on the west.

PORTLAND, ORE.—Three big crews of linemen and a squad of metermen started out a few days ago to connect the light and power service of the Northwestern Electric Company for its customers here. The new company has a distribution system for light and power through the East Side, both in the business and residence sections.

SAN BERNARDINO, CAL.—The sum of $1,500,000 is to be expended within the next year by the Southern California Edison Company in the construction of two big power houses on Bear and Santa Ana creeks, in the San Bernardino mountains. Preliminary work will be commenced at once, and actual construction will be started in the spring.

HOLLISTER, CAL.—Seven transformers of 400 kw. capacity each, will be installed in the new substation of the Coast Counties Gas & Electric Company, now completed, three, as soon as they can be moved into the building and the other four before the coming summer increase in the consumption of energy. The substation building is of reinforced concrete construction with a smooth plaster inside finish and covers a floor space of 21x30 ft. The present equipment of the company will handle a load of 1200 kw.

BAKERSFIELD, CAL.—Initiative petitions will be put in circulation here right away looking to the calling of an election to decide whether control of local public utilities shall be taken from the board of trustees and lodged with the state railroad commission. The matter of public service control is divided into ten separate propositions, each referring to the control of a certain public utility as follows: Street railroads, railroads, other common carriers, water corpora-

tions, gas corporations, electrical corporations, telephone companies, telegraph companies, warehouse men and wharfingers.

SAN FRANCISCO, CAL.—Commissioner Eshleman presided at the hearing of an application in which Judge Chas. W. Slack, on behalf of the California Power & Manufacturing Company seeks to secure the right to furnish electric energy from a 10,700 h.p. installation on Hat Creek, in Shasta county, to the district in Lassen and Siskiyou counties. The Pit River Power Company that controls water rights, appeared and opposed the granting of a certificate of public necessity and convenience in the territory embraced in a prior order of the commission, allowing the Pit River concern to operate therein.

LOS ANGELES, CAL.—Plans to develop a municipal power project, involving an expenditure of $10,000,000 in Mono county, were outlined before the state board of water power control by attorneys and engineers representing the city of Los Angeles. A tunnel 26 miles long, to carry water from streams tributary to Mono Lake into the Owens River Valley, where it will be merged with the Los Angeles aqueduct project, is one of the most pretentious features of the proposed undertaking. Three power plants in Mono county are also projected. These plans were revealed in explanation of Los Angeles' opposition to the application of E. G. Ryan who had asked for permits to appropriate water from Rush Creek and Leevining Creek, in the vicinity of Mono Lake.

TRANSPORTATION.

WINSLOW, ARIZ.—J. F. Mahoney has applied to the city council for a franchise for a street railway, stating that work will begin at once upon granting of the franchise.

VALLEJO, CAL.—The Northern Electric Railway will erect a warehouse at Front and M streets in Sacramento, at a cost of $23,900. Murcell and Haley have the contract.

VISALIA, CAL.—An ordinance has been adopted by the city trustees granting to the Big Four Electric Railway Company a 50-year franchise to construct and operate a railway along certain streets of this city.

DIXON, CAL.—The town trustees have decided to grant a franchise to the Sacramento Valley Electric Company and to the Northern Electric Railroad Company, permitting them to build and operate an electric railway on First street, providing the state railroad commission will allow the crossing of the Southern Pacific tracks in the northern part of town to be made at grade. The franchise has a 50-year limitation and work must begin within three months after granting of the permit, and the track finished in the town within six months.

SALT LAKE CITY, UTAH.—Regular service over the Utah Light & Railway Company's interurban extension into Davis county has been inaugurated. Official announcement of the opening of the new line was made by General Manager Joseph S. Wells following a trip of inspection made by Mr. Wells, accompanied by George Manning, superintendent of railways; John Williams, assistant superintendent; L. L. Dagron, engineer; O. A. Honnold, electrical engineer, and W. M. Scott, superintendent of electric lines and service. The territory tapped by this thirteen-mile extension into Davis County is one of the richest in the State of Utah. Truck gardening and other forms of intensive farming are followed there, and the improved service afforded should add much to build up this locality.

SALT LAKE CITY, UTAH.—Decision to spend $100,000 in constructing joint carbarns for the use of the Salt Lake and Ogden or Bamberger Line and the Salt Lake and Utah or Orem Line, was reached at a conference between Simon Bamberger, president of the former company, and W. C. Orem, president of the latter company. These barns will be located on Third West between Third and Fourth South, according to the statement issued by Mr. Bamberger after the conference. They will be approximately 90 ft. by 130 ft. and will contain 3000 ft. of trackage with space to accommodate 60 cars. The move of the two roads in deciding upon joint carbarns is in line with the announcements made some time ago that a joint terminal station will be built on the west side of West Temple between Second and Third South streets.

TELEPHONE AND TELEGRAPH.

GLOBE, ARIZ.—According to W. A. Candless of the Mountain States Telephone & Telegraph Company, a new line is to be built from Globe to Ray. The other end of the line has been completed and work will start shortly at the Globe end of the line.

SAN FRANCISCO, CAL.—The Pacific Telephone & Telegraph Company has just approved estimates amounting to $453,850 for the construction of a toll line across California and Nevada, to be made part of a transcontinental line that will make possible continuous telephonic communication between San Francisco and New York. The company's new line will extend from San Francisco to Calvada, on the California-Nevada boundary line and thence to Wendover, Nev., near the Nevada-Utah boundary line, where it will connect with the Mountain States Telephone & Telegraph Company. The Mountain States Company is now building a line from Denver to Wendover. Telephone communication is now possible between Denver and New York, and it only remains for the Pacific and Mountain States companies to build and connect their lines to make telephone communication possible from the Pacific to the Atlantic. It is estimated that the cost of the toll line from San Francisco to Calvada will be a little over $86,000, while the cost from Calvada to Wendover will be something over $367,000.

WATERWORKS.

TACOMA, WASH.—A contract has been awarded to E. R. Moore for $19,000 for the construction of a water pipe line four and one-half miles long. Wood pipe will be used.

GLENDORA, CAL.—Glendora voters have authorized a bond issue in the sum of $25,000 for the purpose of establishing a municipal water system. The municipality has an option on a private plant at present supplying the city to cost $10,000.

BOW ISLAND, ALTA.—The town council has signed up with the Bow Island Sewer, Pipe & Tile Company to supply them with natural gas and water. The company is capitalized at $250,000. Work on the plant is to be started immediately.

LOS ANGELES, CAL.—Bids will be received up to February 2, by board of supervisors of Los Angeles county, for a pipe line franchise granting the right to lay and maintain for a period of 40 years, a system of water pipes in certain portions of the county.

MANHATTAN BEACH, CAL.—An ordinance has been adopted by the board of trustees ordering the issuance of municipal bonds of the city of Manhattan Beach, in the sum of $111,000 for the acquisition, construction and completion of a municipal waterworks system. The bonds are 150 in number, of $200, $500 and $1000 denomination, with interest at 6 per cent per annum, payable semi-annually.

RENO, NEV.—Councilman Frish brought about a precipitation of the water question when he introduced an ordinance at a recent meeting which called for support of the Galena Creek project which has been forwarded by Jas. J. Chambers of Salt Lake. He moved that the council adopt the plan suggested by Chambers to sell to the city a municipal water supply for $750,000, which was to be supplied from the water of Galena Creek. The matter was laid over.